

# EDN<sup>®</sup>

THE DESIGN MAGAZINE OF THE ELECTRONICS INDUSTRY

## COVER STORY:

# Mixed analog-digital simulation

PG 38

✓  
SEPTEMBER 1, 1994

Out in Front  
pg 15



Flash-memory modules  
pg 51

High-speed connectors  
pg 65

Design Ideas  
pg 77

Charge batteries safely in 15 minutes by detecting voltage inflection points  
pg 89

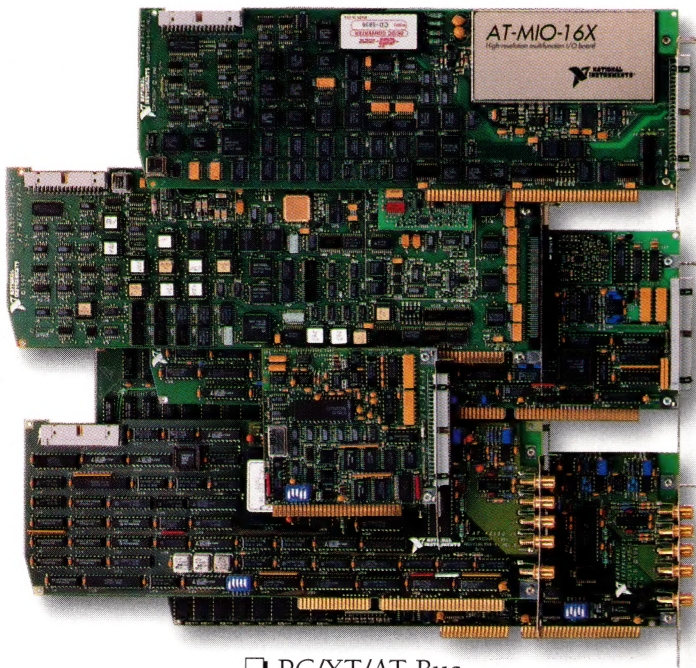
New Products  
pg 97

Jack Ganssle:  
The paperless office?  
pg 131





# Multiple Choice.



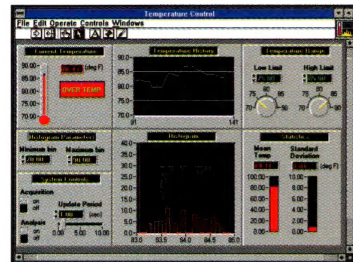
☐ PC/XT/AT Bus



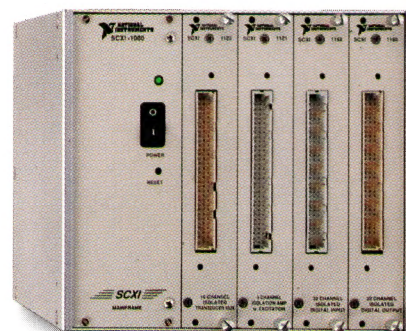
☐ Parallel Port



☐ PCMCIA



☐ Software



☐ Signal Conditioning

## All the Right Answers for Your PC Data Acquisition Systems

### Plug-In Boards

Our data acquisition (DAQ) solutions feature products for PC/XT/AT, EISA, PS/2, PCMCIA, and parallel port. Innovations include an instrumentation amplifier that settles so fast that accuracy is maintained at all gains and sampling rates, antialiasing filters that cut off at the rate of 90 dB in one-sixth octave, and integrated multiboard synchronization with our RTSI® bus.

### Signal Conditioning

The National Instruments SCXI system is a high-performance, multichannel signal conditioning and signal routing front-end system.

### Driver Software

Our NI-DAQ® driver software for DOS,

Windows, and Windows NT, which is shipped with all our PC DAQ boards, is like a DAQ operating system, with routines for most programming languages, including Visual Basic custom controls.

### Graphical User Interfaces

We pioneered the use of graphical user interfaces for instrumentation software and remain the leader in this technology with our LabVIEW® and LabWindows® application software products.



**Call for your  
FREE DAQ Designer  
(800) 433-3488  
(U.S. and Canada)**



6504 Bridge Point Parkway • Austin, TX 78730-5039 USA • Tel: (512) 794-0100 • 95 (800) 010 0793 (Mexico) • Fax: (512) 794-8411

Branch Offices: Australia 03 879 9422 • Austria 0662 435986 • Belgium 02 757 00 20 • Canada 519 622 9310 • Denmark 45 76 26 00 • Finland 90 527 2321 • France 1 48 14 24 24 • Germany 089 7413130  
Italy 02 48301892 • Japan 03 3788 1921 • Netherlands 03480 33466 • Norway 32 848400 • Spain 91 640 0085 • Sweden 08 730 49 70 • Switzerland 056 27 00 20 • U.K. 0635 523545

© Copyright 1994 National Instruments Corporation. All rights reserved. Product and company names listed are trademarks or trade names of their respective companies.

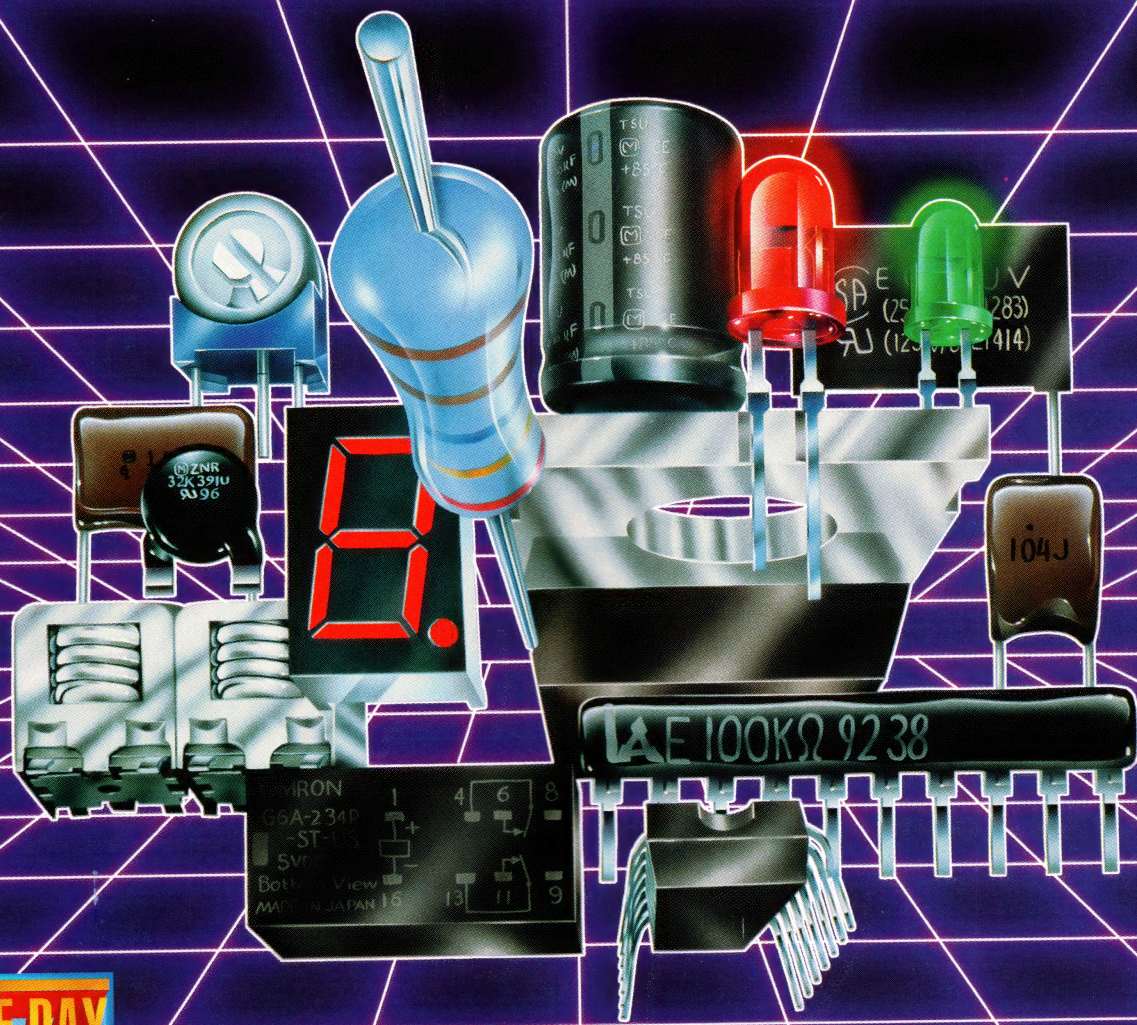
See us at WESCON, booth 1631

See us at SEMICON SW

CIRCLE NO. 32



# Quality Electronic Components Superior Service



On orders placed by  
5:00 pm central time.

**Rated #1 for...**  
**On-Time Delivery!**  
**Availability of Product!**  
**Overall Performance!**

Call, write or fax for your  
**FREE CATALOG today!**

**Digi-Key**  
CORPORATION

701 Brooks Ave. South, Thief River Falls, MN 56701

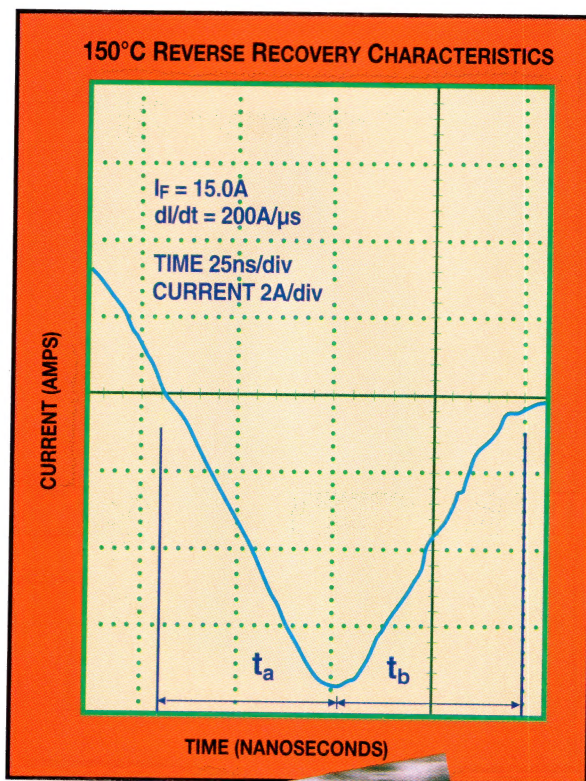
Toll Free: 1-800-344-4539

Fax: 218-681-3380



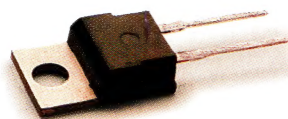
# HARRIS HYPERFAST DIODES: FASTEST RECOVERY ON TWO LEGS.

Nobody beats Harris diodes when it comes to recovery time. Our HYPERFAST diodes are twice as fast as ULTRAFAST. And all Harris diodes give you low forward voltage drop, low leakage, and exceptionally soft recovery, which can cut design costs. And they come in a full range of current ratings, single and dual configuration, with nine popular package types. It's enough to make Harris your one-stop source for diodes. Want to get the jump on your competition? Give us a call.



## Features

- Low leakage
- Low forward voltage drop
- Blocking voltage: 100V-1200V
- Exceptionally soft recovery characteristics
- Dual configurations available
- Nine package types, including low profile



Fastest recovery. Softest landing.  
HYPERFAST – the only way to fly.



Try our AnswerFAX service!

For a line card, call 407-724-3818 and request document #523268.  
Or call 1-800-4-HARRIS, ext. 7228.



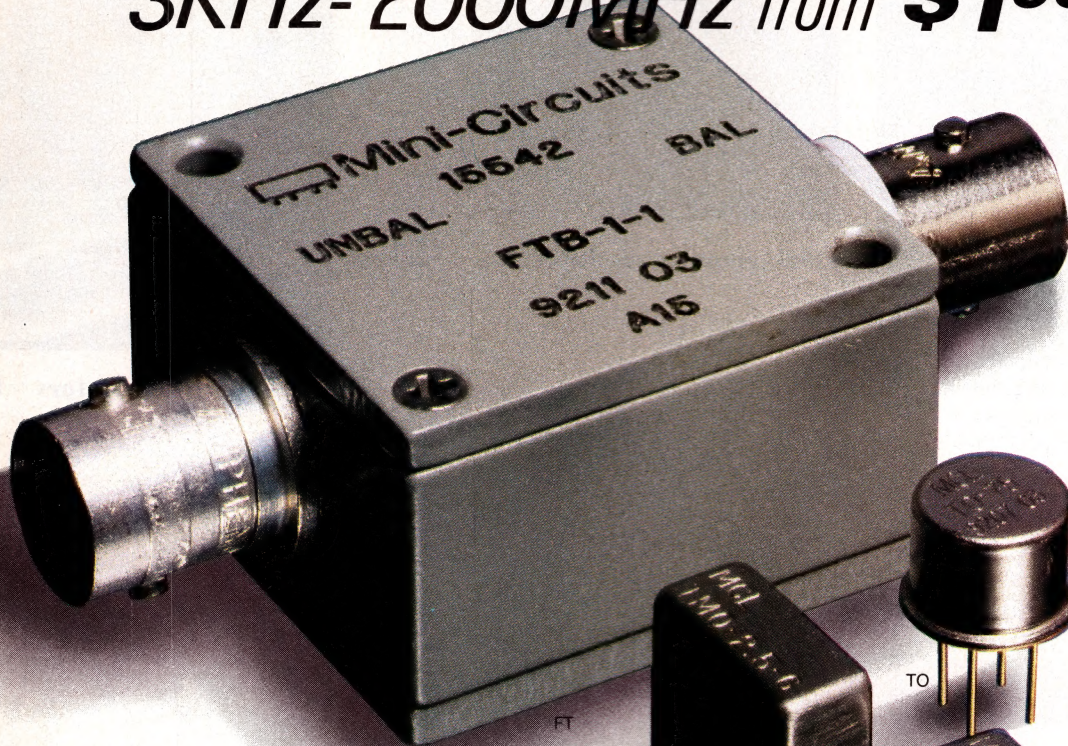
**HARRIS**  
SEMICONDUCTOR



# RF TRANSFORMERS

Over 80 off-the-shelf models...

3KHz- 2000MHz from **\$1<sup>95</sup>**



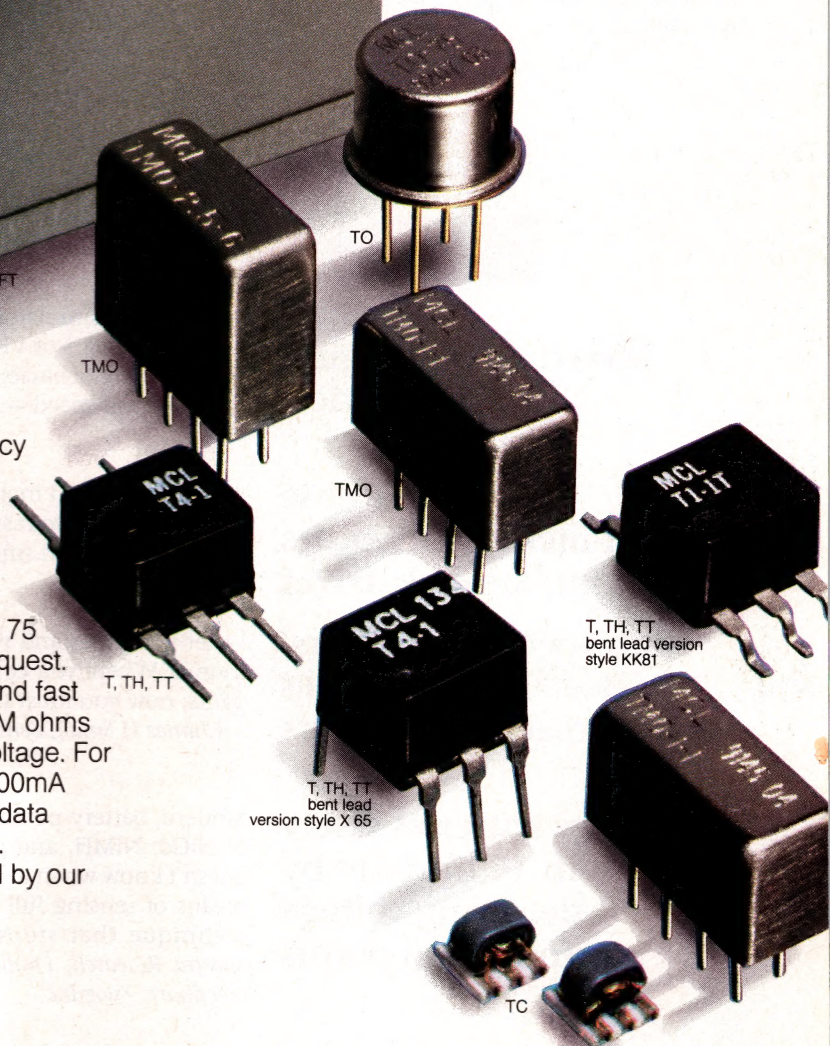
Having difficulty locating RF or pulse transformers with low droop, fast risetime or a particular impedance ratio over a specified frequency range?...Mini-Circuits offers a solution.

Choose impedance ratios from 1:1 to 36:1, in connector, TO-, flatpack, surface-mount, or pin versions (plastic or metal case built to meet MIL-T-21038 and MIL-T-55631 requirements\*). Coaxial connector models are offered with 50 and 75 ohm impedance; BNC standard, other types on request.

Ultra-wideband response achieves low droop and fast risetime for pulse applications. Ratings up to 1000M ohms insulation resistance and up to 1000V dielectric voltage. For wide dynamic range applications involving up to 100mA primary current, use the T-H series. Fully detailed data appear in our 740-pg RF/IF Designer's Handbook.

Need units in a hurry?...all models are covered by our exclusive one-week shipment guarantee. Only from Mini-Circuits.

\*units are not QPL listed.



**Mini-Circuits®**

P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718)332-4661

For detailed specs on all Mini-Circuits products refer to • THOMAS REGISTER • MICROWAVE PRODUCT DATA DIRECTORY • EEM • MINI-CIRCUITS' 740- pg. HANDBOOK.

**CUSTOM PRODUCT NEEDS...Let Our Experience Work For You.**

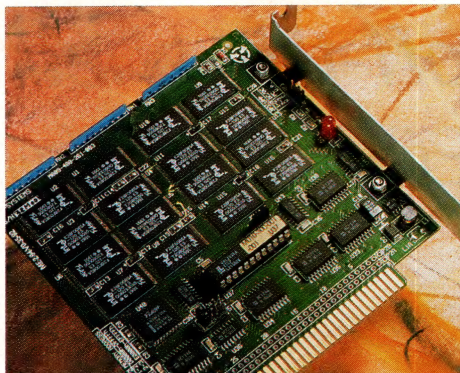
CIRCLE NO. 161

F 71 Rev F



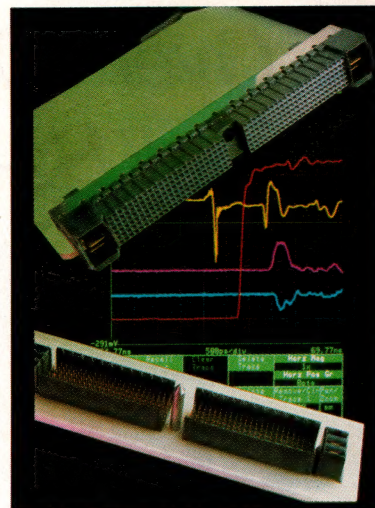


**COVER STORY: Mixed analog-digital simulation.** Photo courtesy Cadence Design Systems; concept and photography by Imagination.



**Flash-memory modules**

**51**



**High-speed connectors**

**65**

## EDN

## DESIGN FEATURES

### **COVER STORY** **Mixed analog-digital simulation**

Mixed-signal simulators now offer languages that extend the digital design languages of VHDL and Verilog to analog design. The option to use analog behavioral descriptions simplifies design and increases simulation speed.—*Doug Conner, Technical Editor*

**38**

### **Easy-to-use flash-memory modules emulate disk drives**

Because more and more flash-memory modules look just like familiar disk drives to your system, designing in fast and rugged mass storage has never been simpler.—*Gary Legg, Executive Editor*

**51**

### **High-speed connectors' electrical properties eclipse mechanical traits**

Faster rise times and wider buses have changed all the old rules of thumb. Where you could once spec connectors by the seat of your pants, now you must rigorously analyze connectors.

—*Charles H Small, Senior Technical Editor*

**65**

### **Charge batteries safely in 15 minutes by detecting voltage inflection points**

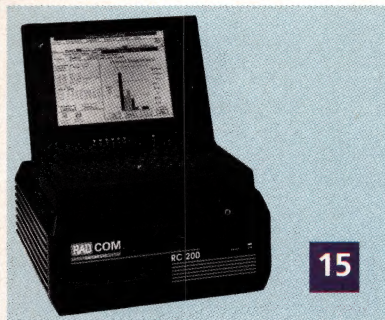
Modern, battery-powered electronic products require rapid charging of NiCd, NiMH, and other types of batteries. But if a fast charger doesn't know when to stop, it can easily cause damage. Conventional means of sensing full charge terminate charging too late. Here's a technique that stops the charging in time.—*Gary Cummings, Spectra Research, Daniel Brotto, Black and Decker Corp, and James Goodhart, Zilog Inc*

**89**



## OUT IN FRONT

Cost of ATM testing drops **15**



Seven-chip set builds digital TV camera **15**

Navigation tool for Internet **15**

Wavetest users get two years to switch **15**

Handheld do-everything test tools undergo a rebirth **16**



Venders lower initial cost of VXI **16**



Dilbert **16**

Support grows for Serial Storage Architecture **18**

ICE emulates 386/486  $\mu$ Ps to 50 MHz **18**

PCI bus conference issues call for papers **18**

### EDN

### DESIGN IDEAS

Solid-state relay saves battery's life **77**  
Off-hook phone line supplies 150 mW **78**  
Cúk converter yields 90% efficiency **80**  
Two LEDs perform rudimentary spectral analysis **82**

### EDN

### COLUMNISTS

The paperless office: must or myth?—by Jack Ganssle, *Embedded Systems Contributing Editor* **131**

### EDN

### PRODUCTS

Computers & Peripherals **97**  
Power Sources **101**  
Integrated Circuits **104**  
Electronic Design Automation **111**  
Test & Measurement **114**  
Embedded Systems **118**

### EDN

### DEPARTMENTS

Staff **10**  
Signals & Noise **25**  
Editorial **29**  
Career Opportunities **127**  
International Advertisers Index **128**

EDN® (ISSN 0012-7515, GST Reg. #123397457, IPM #0280844) is published 38 times per year, bi-weekly with one additional issue per month, by Cahners Publishing Company, A Division of Reed Publishing USA, 275 Washington Street, Newton, MA 02158-1630. Robert L. Krakoff, Chairman and Chief Executive Officer; Timothy C. O'Brien, Executive Vice President/Finance and Administration; Michael Wisner, Senior Vice President/General Manager, Boston Division; Michael Wisner, Vice President/Publishing Director. Circulation records are maintained at Cahners Publishing Company, 8773 South Ridgeline Blvd., Highlands Ranch, CO 80126-2329. Telephone (303) 470-4445. Second-class postage paid at Highlands Ranch, CO 80126-2329 and additional mailing offices. **POSTMASTER: Send address changes to EDN®, PO Box 7500, Highlands Ranch, CO 80126-7500.** EDN® copyright 1994 by Reed Publishing USA. Rates for non-qualified subscriptions, including all issues: US, \$140.00 one year, \$238.00 two year; Canada, \$209.00 one year, \$355.00 two year (includes 7% GST, GST# 123397457); Mexico, \$195.00 one year, \$332.00 two year; Foreign surface \$245.00 one year, \$417.00 two year; Foreign air expedited surcharge add \$152.00 one year, \$304.00 two year. Except for special issues where price changes are indicated, single copies are available for \$10.00 US and \$15.00 foreign. Please address all subscription mail to EDN®, 8773 South Ridgeline Blvd., Highlands Ranch, CO 80126-2329. EDN® is a registered trademark of Reed Properties Inc., used under license.

(Printed in USA)







# Squeeze the most out of your design cycle.

You know time is money. And at Texas Instruments, we can help you speed your product to market. Meaning you are free to do what you do best – create the next breakthrough products.

**Be first to market with leading-edge designs.** From notebooks and PDAs to wireless communications and multimedia, you can harness the power of TI's DSP solutions, low-power 486 microprocessors and mixed-signal devices to design unique products fast. Our industry-leading TMS320 DSP family offers a road map with the flexibility of software-programmable solutions that can migrate into highly integrated, custom DSPs that deliver cost-effective high performance. And compatible logic families and memory devices also help you move your designs easily from 5 V to 3 V.



## **Total Integration in action.**


*Seagate Technology put the power of Total Integration to work when creating their hard disk drives. In addition to combining TI's high-performance DSP cores and application-specific logic with memory and analog cells, TI had the tools and service to help Seagate produce a highly differentiated product. And TI's on-time delivery made a difference. TI provides high-volume, quick-ramp manufacturing capability to meet Seagate's needs as an industry leader.*

**Technical support that gets you up to speed, fast.** Move quickly from selection to prototype with clear, concise technical information and real-world application notes. And C compilers, emulators, development tools, behavioral models and SPICE rules can help you create DSP solutions in record time.

**Setting the benchmark: A 94% on-time delivery record.** At TI, we deliver what we promise. So you won't be left waiting for your ICs. In an expanding market, we set an industry benchmark by having a 94% on-time-to-commit-date delivery record.

**Win the race to market.** Getting to market faster with a better product. That's what business is all about. And with TI, you'll find a unique blend of silicon, support and service. We call it Total Integration.™ You'll call it your competitive edge. To find out more and receive a free subscription to *Integration*, contact Texas Instruments France, MS 94, BP 5, Avenue Jack Kilby, F-06271 Villeneuve-Loubet Cedex.

E X T E N D I N G   Y O U R   R E A C H

 **TEXAS  
INSTRUMENTS**

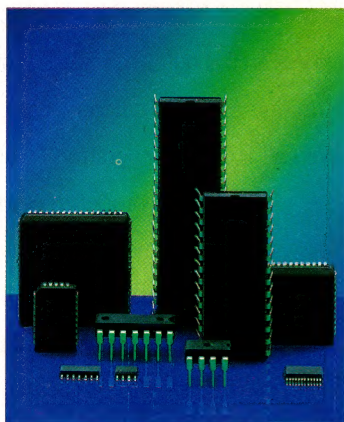


# SIEMENS

## Superior Solutions Down the Line

If you want to take the lead in information technology, it pays to work with a partner who has the widest range of solutions. Starting with line cards – we are the only vendor that can offer analog and digital solutions with optimized DSP macros.

In digital communications, we offer an impressive array of devices in silicon and gallium arsenide for voice, text, data and images. These are the building blocks of modern telecommunications – from digital featurephones to complete ISDN switching systems. Our ESCC88-channel serial controller for data communication, for example, is second to none in performance.



And in pursuit of excellence throughout information technology, we have set the pace in mobile communications, too. With VLSI solutions and custom chipsets, we meet GSM 900 and DECT standards. And, as you would expect, our experienced teams are a match for any challenge in radio frequency engineering.

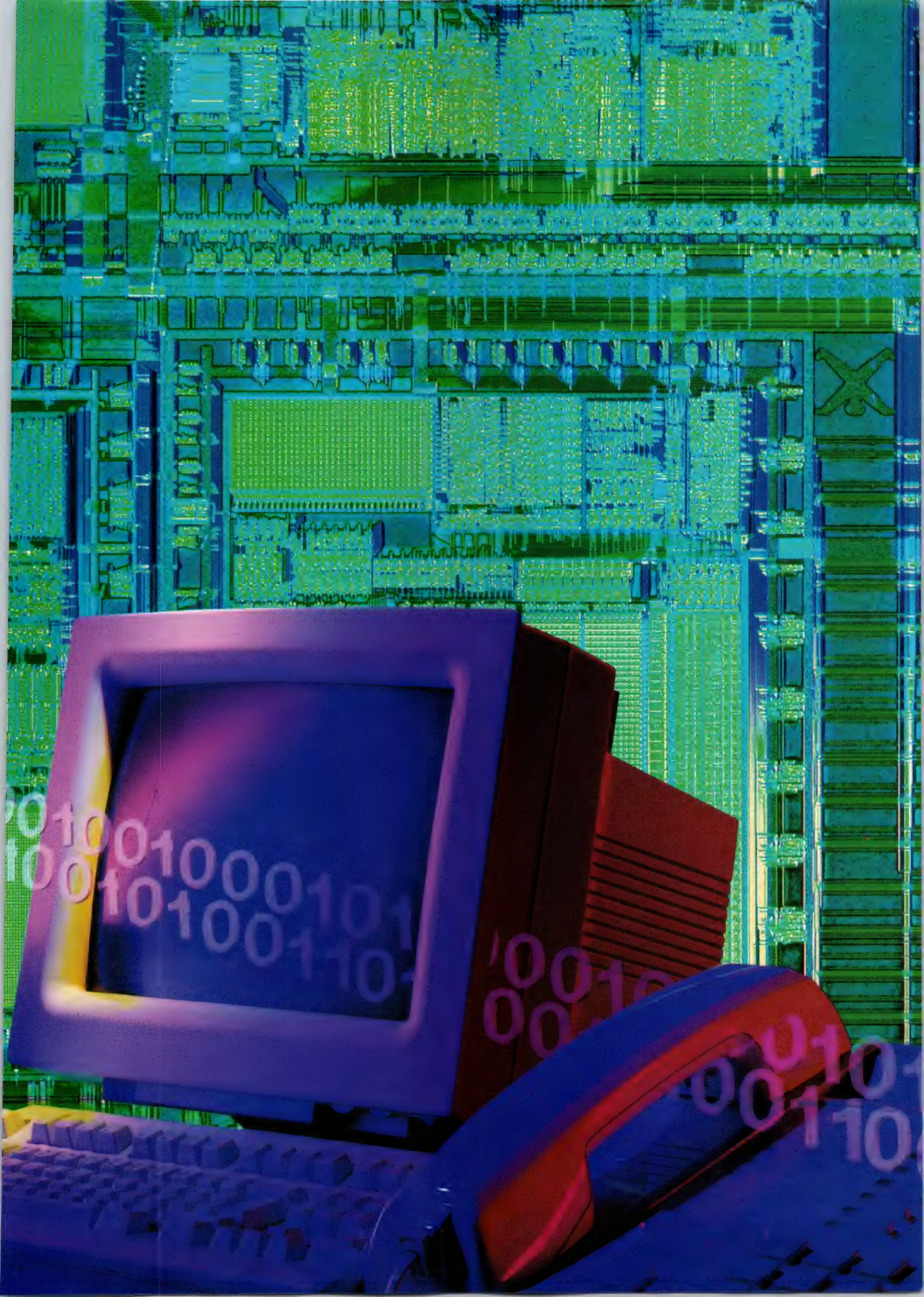
More information by fax  
49-911-3 00 12 38, quoting HL 9117

**Global PartnerChip  
for Systems on Silicon.  
Siemens**

CIRCLE NO. 149









Home Office: 275 Washington St, Newton, MA 02158. EDN Bulletin Board: (617) 558-4241; MCI: EDNBOS; fax (617) 558-4470; phone (617) 964-3030.

**PUBLISHER Jeffrey Patterson (617) 558-4454**

## EDN'S EDITORIAL OFFICES

	<b>EDITOR-IN-CHIEF</b> <b>EXECUTIVE EDITOR</b> <b>MANAGING EDITOR</b>	Steven H Leibson (617) 558-5214; MCI: ednleibson Gary Legg (617) 558-4404; MCI: ednlegg Joan Lynch (617) 558-4215; MCI: ednmorrow	
<b>SENIOR TECHNICAL EDITORS</b>	Charles Small (617) 558-4556; MCI: ednsmall Dan Strassberg (617) 558-4205 MCI: ednstrassberg Brian Kerridge 22 Mill Rd, Loddon, Norwich, NR14 6DR, UK; (508) 528435; fax: (508) 528430; MCI: ednkerridge	<b>EDITORIAL AND ART PRODUCTION</b>	Diane Malone, Manager (617) 558-4263 Kenneth Racicot, Senior Art Director (617) 558-4708 Chinsoo Chung, Associate Art Director (617) 558-4446 Patricia Shaughnessy, Production Editor (617) 558-4206
<b>TECHNICAL EDITORS</b>	John Gallant (617) 558-4666; MCI: edngallant Richard Quinnell (408) 685-8028 (phone and fax); MCI: ednquinnell Anne Watson Swager (610) 645-0544 (phone and fax); MCI: ednswager Markus Levy (916) 939-1642; fax: (916) 939-1650; MCI: ednlevy	<b>PRODUCTION</b>	Andrew Jantz, Group Manager (617) 558-4372 Karen Banks, Manager (617) 558-4441 Alice Dorsey, Associate (617) 558-4601
<b>SPECIAL-PROJECTS EDITOR</b>	Doug Conner (805) 461-9669; fax (805) 461-9640; MCI: edndconner	<b>ASSISTANT TO THE EDITOR-IN-CHIEF</b>	Kathy Leonard (617) 558-4405
<b>SENIOR ASSOCIATE EDITORS</b>	Frances T Granville (617) 558-4344 James P Leonard (617) 558-4324	<b>EDITORIAL SERVICES</b>	Helen Benedict (617) 558-4681
<b>ASSOCIATE EDITOR</b>	Anne Coyle (617) 558-4333	<b>DIRECTOR OF CREATIVE SERVICES</b>	Norm Graf (617) 558-4293
<b>CONTRIBUTING TECHNICAL EDITORS</b>	Robert Pease, Jack Ganssle, David Brubaker, Bill Travis, Don Powers	<b>EDN ASIA</b>	Mike Markowitz, Editor 19F, 8 Commercial Tower, 8 Sun Yip St, Chai Wan, Hong Kong, phone (011) (852) 965 1555; fax: (011) (852) 976-0706

## EDN'S BUSINESS AND ADVERTISING OFFICES

ADVERTISING SALES DIRECTOR	Paul Rothkopf (617) 558-4651	CONTRACTS	Muriel Murphy (617) 558-4451	
MARKETING/BUSINESS DIRECTOR	Deborah Virtue (617) 558-4779	CIRCULATION	Debbie Barela (303) 470-4000	
CUSTOM PUBLISHING SERVICES	Patricia Tyler, Director (617) 558-4526	MARKETING COMMUNICATIONS	Jean Graham (617) 558-4698	
ASSISTANT TO PUBLISHER	Maria McGrath (617) 558-4346			
NEW ENGLAND CHRIS PLATT (617) 964-3730 fax: (617) 332-7128	NEW YORK/NEW JERSEY/ MID/SOUTH ATLANTIC DIANE DRISCOLL (203) 326-5161 fax: (203) 326-5160	IL/IN/KY/OH/TN/ TX/OK/FL/SC JOANN CANNON (708) 635-8800 fax: (708) 635-0929	IL/MI/MN/NE/IA/KS/ND/SD/WI/ MO/AL/AR/GA/MS/CANADA JACK JOHNSON (708) 635-8800 fax: (708) 390-2815	ARIZONA DONNIE JONES ADAMS (408) 243-8838 fax: (408) 243-2144
ORANGE/RIVERSIDE/SAN DIEGO COUNTIES/LOS ANGELES/ SOUTHERN CA/NV SUSAN N GREEN (714) 851-9422 fax: (714) 752-6867	COLORADO/ WASHINGTON/OREGON ROGER GAW (408) 243-8838 fax: (408) 243-2144	NORTHERN CA/SILICON VALLEY DONNIE JONES ADAMS BETTINA MCGOWAN ROGER GAW (408) 243-8838 fax: (408) 243-2144	EUROPEAN OPERATIONS TULLY GIACOMAZZI (011) 49 89 769 02 391 fax: (011) 49 89 769 02 144	UK JOHN WADDELL (011) 44 81 312 4696 fax: (011) 44 81 312 1078
NORWAY/SWEDEN/FINLAND ROLAND NIHLMAR LARS GRUNBERGER (011) 46 8616 0760 fax: (011) 46 8616 0777	DENMARK AASE KISBORG (011) 45 33 14 9888 fax: (011) 45 33 14 9288	NETHERLANDS/BELGIUM/ GERMANY ZIP CODES 0-5 ALBERT TICHELER (011) 31 40 41 37 27 fax: (011) 31 40 42 0430	GERMANY ZIP CODES 6-7 RENATE MUNK (011) 49 6272 2345 fax: (011) 49 6272 2167	GERMANY ZIP CODES 8-9 MARGARETHE MUNCHMEIER (011) 49 89 222 015 fax: (011) 49 89 299 160
SPAIN LUIS GINER (011) 343 894 43 26 fax: (011) 343 894 88 37	AUSTRIA SVEN KOLLENSPERGER (011) 43 732 79 34 55 fax: (011) 43 732 79 34 58	ISRAEL ASA TALBAR (011) 972 35 223 621 fax: (011) 972 35 242 177	ITALY ROBERTO LAURERI (011) 39 2 236 2500 fax: (011) 39 2 236 4411	SWITZERLAND ROSWITHA N BRIAND. (011) 41 1261 4690 fax: (011) 41 1251 4542
FRANCE ALAIN FAURE (011) 331 4629 4629 fax: (011) 331 4093 0337	HONG KONG ADONIS MAK (011) 852 965 1555 fax: (011) 852 976 0706	JAPAN KAORU HARA (011) 813 3389 1822 fax: (011) 813 3389 1761	KOREA JEONG-GWON SEO (011) 82 2752 4392 fax: (011) 82 2752 4394	SINGAPORE/MALAYSIA HOO SIEW SAI (011) 65 738 0122 fax: (011) 65 738 2108
TAIWAN PARSON LEE JOHN SHIH (011) 886 2711 4833 fax: (011) 886 2741 5110	AUSTRALIA ALEXANDRA HARRIS-PEARSON (011) 612 299 5677 fax: (011) 612 299 6178	TURKEY CENGIZ EREN (011) 90 216 345 3473 fax: (011) 90 216 346 2464	INSIDE SALES LISA BARRIERE (617) 558-4361 fax: (617) 558-4328	INFO CARDS/ LITERATURE LINK MELISSA BACHMAN (617) 558-4282 fax: (617) 558-4328
RECRUITMENT JACQUELINE DANIELS (617) 558-4488 (617) 630-3925	PRODUCT MART JOANNE DORIAN (212) 463-6415 fax: (212) 463-6404	CAHNERS MAGAZINE DIVISION ROBERT KRAKOFF, President, CEO Cahners Publishing	CAHNERS MAGAZINE DIVISION MICHAEL WISNER Senior VP/General Manager Boston Division	CAHNERS MAGAZINE DIVISION TOM DELLAMARIA Senior VP/ Production & Manufacturing



# SRAM's when fast isn't fast enough for you



#### Distributors for Integrated Circuit

UK Ambar Components Ltd., Tel. 0044-844-261144, Fax 0044-844-261789  
 UK Hero Electronics Ltd., Tel. 0044-525-405015, Fax 0044-525-402383  
 UK Sequoia Technology Ltd., Tel. 0044-734-258000, Fax 0044-734-258020  
 F SCAIB S.A., Tel. 0033-1-46872313, Fax 0033-1-45605549  
 F Tekelek Airtronic S.A., Tel. (33) 1-46232425, Fax (33) 1-45072191  
 D Beck GmbH & Co., Tel. 0911-3405-0, Fax 0911-340528  
 D Dema GmbH, Tel. 089-286037, Fax 089-283509  
 D Jermyn GmbH, Tel. 06431-508-0, Fax 06431-54662  
 D Rein Components GmbH, Tel. 02153-7330, Fax 02153-733244  
 I ESCO Italiana S.P.A., Tel. 0039-2-2409241, Fax 0039-2-2409255  
 I Melchioni S.P.A., Tel. 0039-2-5794364, Fax 0039-2-55181914  
 NL Texim Electronics, Tel. 0031-5427-3333, Fax 0031-5427-33888  
 E SELCO, Tel. 0034-1-6371011, Fax 0034-1-6371506  
 CH Hemar AG, Tel. (41) 064-560212, Fax (41) 064-560211  
 A Burisch, Tel. 0043-1-27720-0, Fax 0043-1-27720-278  
 N.S.S.F. J. Hatteland Electronic A/S, Tel. 0047-53-765111, Fax 0047-53-765339  
 DK Mer-el A/S, Tel. 0045-42-571000, Fax 0045-42-572299  
 DK Peter Petersen A/S, Tel. 0045-86-836211, Fax 0045-86-836383  
 TR Empia Elektronik A.S., Tel. 0090-212-5993050, Fax 0090-212-5985353  
 IL Ralco Components, Tel. 0097-236951053, Fax 0097-236951743

128kx8	15*, 17, 20, 25 ns	32SOJ
256kx4	15*, 17, 20, 25 ns	28SOJ
64kx18	17, 20, 25 ns	52SOJ

\*) under development

SHARP ELECTRONICS (EUROPE) GMBH  
 Microelectronic Division (MED)  
 SonninstraÙe 3, 20097 Hamburg  
 Phone +49-40/2376-2286, Telex 2 161 867  
 Telefax +49-40/2376 22 32

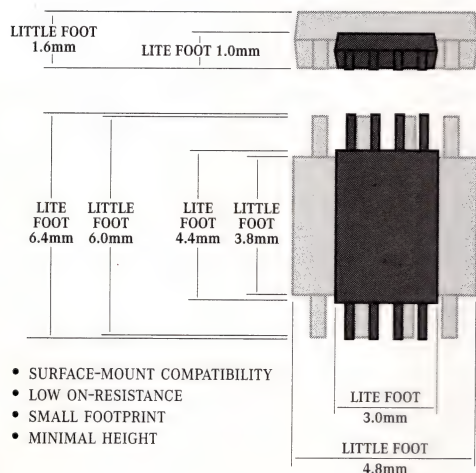
SHARP ELECTRONICS (EUROPE) GMBH  
 Liaison Offices in  
 Paris · Milano · Stuttgart · Nürnberg · London · Dublin

# SHARP

THE IDEAS COMPANY



# Introducing LITE FOOT. Everything you like about LITTLE FOOT power MOSFETs, only smaller.



LITE FOOT™ is about half the size of LITTLE FOOT®, but delivers the same big benefits for space-sensitive and/or battery-operated applications.

Siliconix, the pioneer in 8-lead SOIC power MOSFETs, has redefined the performance of ultra-miniature, surface-mount power. The result is a new family of n-channel and p-channel devices that delivers on-resistance as low

as 50 mΩ. Further, LITE FOOT features TSSOP surface-mount compatibility, and offers gate drive voltages as low as 2.7 V and currents as high as 4.2 A.

In short, LITE FOOT is the smallest discrete power MOSFET in the world. It occupies only 6.4 x 3.0 millimeters of board space. And at a remarkable 1.1 mm high, it's the first power





LITE FOOT Part No.	TYPE	$V_{DS}$ (V)	$r_{DS(on)}$ (m $\Omega$ )*	$I_A$ (A)
Si6436DQ	Single N-Ch	30	50	4.2
Si6956DQ	Dual N-Ch	20	100	2.5
Si6433DQ	Single P-Ch	-12	75	3.5
Si6447DQ	Single P-Ch	-20	100	3.0
Si6953DQ	Dual P-Ch	-20	200	1.7
Si6542DQ	Complementary N-Ch P-Ch	20 -20	100 200	2.5 1.7

\* On-Resistance shown at  $V_{GS} = 10$  V, except Si6433DQ shown at  $V_{GS} = 4.5$  V

MOSFET thin enough to fit into any standard PCMCIA card. Even double-sided circuit boards are a snap.

What's more, LITE FOOT's mini package maximizes power dissipation, too — over 1.5 W in a tiny

8-lead TSSOP. But best of all, you don't need an external heat sink other than the PC board itself.

So if your designs keep shrinking, but your power management needs keep getting bigger, LITE FOOT is the solution.

Contact your local TEMIC sales office, or call 1-800-554-5565, ext. 931 for a LITE FOOT design guide.

**Siliconix**  
A Member of the **TEMIC** Group





When Sony specified JST printed circuit board connectors for their TV's, it wasn't just for their measured-in-microns precision.

It wasn't only for their high-density capability, their

zero-defect manufacturing, or even their just-in-time delivery.

Of course, all of that was important. But one thought was more important still: if you're aiming to build

the world's most reliable TV, you'd better insist on connections to match.

For details of the whole JST connector range, simply call any of the JST offices below.

# JST

## The Quality Connection

**BELGIUM**  
JST Europe N.V.,  
Kamphenhout, Belgium.  
Tel: (016) 60 05 25.  
Fax: (016) 60 58 77.

**GERMANY**  
JST Deutschland GmbH,  
Winterbach, Germany.  
Tel: (07181) 4007-0.  
Fax: (07181) 4007-21.

**UK & IRELAND**  
JST (UK) LTD.,  
Halesworth, Suffolk.  
Tel: (0986) 874131.  
Fax: (0986) 874276.

**FRANCE**  
JST France S.A.,  
Vitry-le-François, France.  
Tel: (1) 43 26 74 46 92.  
Fax: (1) 43 26 72 10 88.

**SPAIN**  
JST España S.A.,  
Barcelona, Spain.  
Tel: (3) 347 88 33.  
Fax: (3) 433 11 04.



## SEVEN-CHIP SET BUILDS DIGITAL TV CAMERA

A seven-chip set of ICs from Hitachi lets you build small, CCD-based, digital-TV cameras. The chips comprise the H8/337  $\mu$ C, the HA118144 correlated double-sampling/automatic gain-control (CDS/AGC) IC, the HD49306 9-bit A/D converter, the HD49801 video DSP, the HD49803 timing generator, the HD49307 three-channel, 8-bit D/A converter, and the HD49802 electronic-zoom IC. Because of the digital-camera architecture, this chip set reduces the number of camera adjustments to five from the typical 10. In addition, the DSP technology suppresses the false signals associated with CCD image sensors.

The digital-camera chip set accommodates CCDs with effective horizontal resolutions to 768 pixels. CCDs used with this chip set should employ the common color-difference line-sequential scanning system. The CDS/AGC IC amplifies and compensates the CCD's output signal and feeds the processed signal to the DSP.

The DSP generates 8-bit digital luminance (Y) and chroma (C) data

from the processed CCD output in NTSC or PAL formats. All image-quality manipulation, including color clipping, gamma compensation, and color gain, occur within the DSP. For analog-output cameras, you can feed the digital output of the DSP directly to the chip set's three-channel D/A converter.

A member of the company's H8  $\mu$ C family, the H8/337, controls all digital-camera functions. This  $\mu$ C incorporates a 32-kbyte program memory and 1 kbyte of RAM. You can get the device in masked or one-time-programmable (OTP) ROM versions. The OTP device is more expensive and generally used for development.

The chip set is available in several packaged versions. A prototype chip set, model HMM49111, costs \$95. The HMM49101 basic production chip set costs \$65 (10,000), and the HMM49104 basic production chip set with electronic zoom costs \$85 (10,000).—by Steven H Leibson  
Hitachi America Ltd, Brisbane, CA, (415) 589-8300.

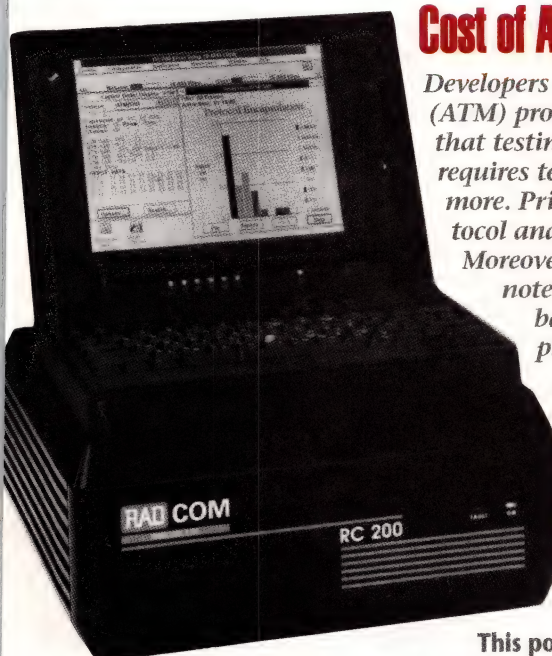
Circle No. 577

## Navigation tool for Internet

Digital Equipment Corp will provide the Mosaic navigation tool for the Internet with its computer systems, under a licensing agreement with Spyglass Inc, Champaign, IL. Spyglass is a commercial licensee of Mosaic for the National Center for Supercomputing Applications at the University of Illinois/Urbana-Champaign, developer of Mosaic. DEC will offer Mosaic on all of its computer systems, including Alpha AXP and Intel personal systems, others running the DEC OSF 1, OpenVMS, Windows, and Windows NT operating systems, and the Pathworks network operating system.

—by Fran Granville

**Digital Equipment Corp**, Maynard, MA, (508) 264-5358. **Circle No. 579**



## Cost of ATM testing drops

Developers of asynchronous-transfer-mode (ATM) products should rejoice at the news that testing their prototypes no longer requires test sets that cost \$45,000 or more. Pricing for Radcom's RC-200-C protocol analyzer begins at under \$15,000.

Moreover, the unit, which is based on a notebook PC running Windows-based software, accommodates plug-ins that adapt the device to fiber-optic and coaxial interfaces. Four plug-ins are available; a unit that includes all four costs less than \$25,000.

—by Dan Strassberg

**Radcom**, Mahwah, NJ, (201) 529-1100. **Circle No. 578**

This portable ATM protocol analyzer significantly cuts the cost of debugging prototype ATM products.

## Wavetest users get two years to switch

When Wavetek Corp (San Diego) decided to exit from the data-acquisition and test-applications-development software market, the company felt obligated to its customer base. Wavetek is transferring responsibility for Wavetest to National Instruments (NI), which will provide support until June 1, 1996. In the interim, NI will work with users of Wavetest, Wavetest VIP, and Wavetest XTM to help them migrate to NI's data-acquisition application-development packages, LabView and LabWindows/CVI.

—by Dan Strassberg

**National Instruments**, Austin, TX, (512) 794-5760.

**Circle No. 580**



## Vendors lower initial cost of VXI

From the start, the VXI community has maintained that the cost of VXI cages and modules is not a good indicator of real system cost. By the time you assemble a working VXI system and keep it running for a year or so, your costs would be lower than those for a system comprising more traditional instruments. Moreover, VXI proponents assert, your savings increase as you build and maintain more VXI systems. Although many system integrators have found this to be so, others were put off by VXI's initial costs.

Hewlett-Packard, a leader in B-size VXI modules, which are less expensive than the larger and more common C-size units, is working to lower VXI's initial costs. With embedded-controller supplier Radisys Corp and automotive and avionics test-equipment-supplier C&H Technologies Inc, HP's VXI catalog has recently added a number of low-cost products. Many of these are in (or for) B-size packages. The new products include B- and C-size card cages, C-size 64- and 100-MIPS PA-RISC embedded controllers (\$8900 and \$14,600), and a B-size embedded controller with various i486 CPUs (from \$4000). Instrument modules include 32- and 64-channel B-size ADC modules (\$3950 and \$4900).

—by Dan Strassberg

**C&H Technologies Inc**, Austin, TX, (512) 251-1171.

**Circle No. 581**

**Hewlett-Packard Co**, Santa Clara, CA, (800) 452-4844.

**Circle No. 582**

**Radisys Corp**, Beaverton, OR, (503) 646-1800.

**Circle No. 583**

**Cahners acquires In-Stat.** Cahners Publishing has acquired In-Stat, a market research company serving the electronics industry. In-Stat provides clients with information on 15 industry segments, custom consulting and consumer surveys, specialized market-research projects, and a monthly newsletter, *The In-Stat Electronics Report*.

**Cahners Publishing Co**, Newton, MA, (671) 964-3030.

**Circle No. 584**

## Handheld do-everything test tools undergo a rebirth

Since their 1991 introduction and their capture of an *EDN* Innovation award, Fluke Corp's ScopeMeters have by all accounts been some of the industry's most successful test-and-measurement products. Fluke, which has no intention of losing its sales lead, hasn't been sitting by idly. The company has made many improvements, particularly in ease of use. The result is the ScopeMeter Series II, which includes four 5¼ × 10¾ × 1¾-in. models, each of which weighs 4 lbs with batteries. The original units, models 93, 95, and 97, continue to be available.

Like the originals, the Series II units combine ±3200-count DMMs with 50-MHz-bandwidth digital storage oscilloscopes. The 91 (\$1295) has a single channel; the 92 (\$1595), 96 (\$1895), and 99 (\$2195) have two. Compared with the 96, the 99 offers twice as many memories to store waveforms and setups. (The 91 and 92 do not offer such memories.) The 99 also performs waveform math and includes a signal generator and a component tester. Of the original family, only the 97 offers a back-lit display; in the Series II, all models offer such displays.

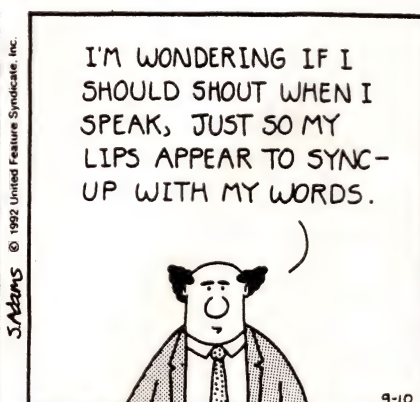
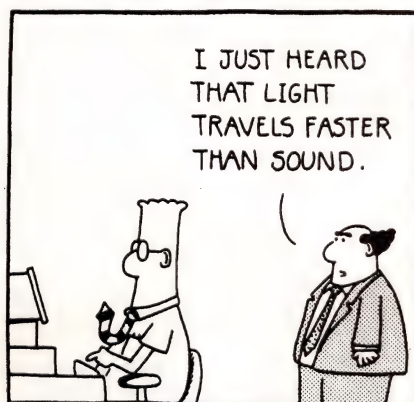
The new units make a noticeable improvement in display contrast, and the company has added a gray-scale capability. The displays are transreflective, which means that when the ambient light is good, you can turn off the backlighting and thus extend the battery life. With the backlighting on, the units operate for four hours from the included NiCd cells. Recharging the cells inside the units takes 16 hours, but an optional external charger does the job in about one-fifth that time. You can also substitute nonrechargeable alkaline cells for the NiCds and run the units for about six hours.

A measure menu gives you direct access to 33 measurements (18 on the 91 and 92). A mode that Fluke calls "continuous autoset" (but most users will proba-

(continued on pg 18)

## DILBERT® by Scott Adams

DILBERT: ©1989 United Feature Syndicate, Inc.





# High Performance Software for High Performance Designs



**W**hy limit your digital designs by using a less capable EDA system? Performance designs require the technical sophistication of the **Design Center** with the PLogic digital circuit simulator. Efficiently verify and debug your digital designs using:

- *advanced timing analysis.* True digital min-max timing analysis helps you find timing problems in your design using the range of delay specified by the manufacturer. This technique can find problems that simple single-delay methods can't—even with multiple runs.
- *interactive reporting of hazard conditions.* When there are problems with your design, such as setup/hold or worst-case timing violations, the **Design Center** eliminates the guesswork. Detailed warning messages lead you directly to the timing errors; interactive capabilities help you automatically associate selected messages with corresponding waveforms.

- *the most sophisticated PLD and CPLD synthesis system at any price.* Built around MINC Incorporated's PLDesigner-XL synthesis engine, this programmable logic synthesis system (PLSyn) is the only desktop product that allows you to design and simulate a system containing programmable logic, discrete digital, and analog parts all on the same schematic. PLSyn is sold as an option to the **Design Center**.
- *a system with a future.* There is an upgrade path with modest price increments all the way to the most complete configuration which includes mixed digital/analog simulation, analog performance optimization, and signal integrity analysis. And, all files are upward compatible.

MicroSim continues to provide personal and powerful Desktop EDA systems with unrivaled price/performance. For more information about our digital **Design Center** system, call toll free at (800) 245-3022 or FAX at (714) 455-0554.



**MicroSim Corporation**  
*The Desktop EDA Company*

20 FAIRBANKS • IRVINE, CA 92718 • USA • (714) 770-3022  
(800) 245-3022 • FAX: (714) 455-0554 • BBS: (714) 830-1550

Design Center and PSpice are registered trademarks of MicroSim Corporation. All other trademarks are the property of their respective owners.

• Circle No. 150 for PC • Circle No. 152 for Workstation



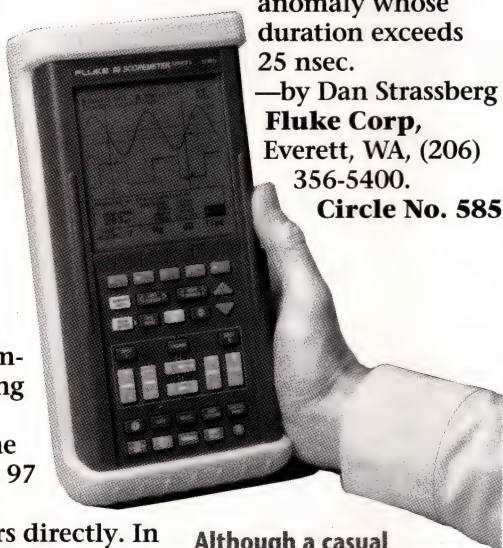
bly call "autoranging") searches for good-trigger, sweep-speed, and vertical-range settings every time you change the input signal. At any time, pressing a single button summons information on how to operate the controls; the information appears as a band of text across the screen. Of the original ScopeMeters, only the 97 provides an optically isolated RS-232C port. All four Series II models offer such ports; they allow transferring data to a host computer running appropriate software. The ports on the 97 and 99 also drive printers directly. In addition, the 99's port permits remote control.

In the meter mode, selecting "min/max" activates a TrendPlot feature that provides a graph of the input sig-

nal's moving average surrounded by graphs of the minimum and maximum values attained by the input over a time interval equivalent to 1 pixel. In the scope mode, the same selection displays the waveform's envelope. The scope mode also includes a glitch-capture feature that displays any signal anomaly whose duration exceeds 25 nsec.

—by Dan Strassberg  
**Fluke Corp.**  
Everett, WA, (206)  
356-5400.

Circle No. 585



Although a casual observer might easily mistake the units in the ScopeMeter Series II for their still-available progenitors, the new units offer a bevy of features that enhances their usefulness.

## Support grows for Serial Storage Architecture

Disk-manufacturer Micropolis has joined backers of the Serial Storage Architecture (SSA) with the production and shipment of prototype SSA disk drives to selected OEMs. SSA is a serial interface for mass storage that offers higher performance, easier integration, and larger configurations than today's parallel SCSI. It provides a total bandwidth of 80 Mbytes/sec and has lower overhead delays than SCSI, giving substantially higher performance at the subsystem level. SSA supports as many as 128 storage devices on a single link, and devices may be as much as 20m apart.

—by Gary Legg

**Micropolis Corp.**, Chatsworth, CA, (818) 709-3300.

Circle No. 586

## ICE emulates 386/486 $\mu$ Ps to 50 MHz

The ERX 548 in-circuit emulator extends Zaxtek's 32-bit in-circuit-emulator (ICE) family into the x86 realm. Comprising the EZX main chassis and three ERX personality modules, the ICE can emulate processors with external bus speeds to 50 MHz, including the clock-doubled 66-MHz  $\mu$ Ps. A proprietary, high-speed parallel interface connects the ICE to a host PC and downloads object code to the emulator at 1 Mbyte/sec. Real-time trace memory comprises 8192 80-bit words. You can trigger on as many as four pre-set breakpoints or break execution from the PC's keyboard. The ICE's ERX 548P personality module emulates the 80486DX, 80486DX2, 80486SX, and ODP486SX  $\mu$ Ps and the 80487SX math coprocessor. The 80386DX version of the ERX 538P personality module emulates the 80386DX, TI486DLC, Am386DXL, Am386DXLV, and Cx486DLC  $\mu$ Ps. The 80386SX version of the ERX 538P personality module emulates the 80386SX, TI486SLC, Am386SXL, Am386SXLV, Cx486SXC, and Cx486SXL-V  $\mu$ Ps. The emulator with one  $\mu$ P personality pod, 1 Mbyte of emulation memory, and source-level debugging software costs \$33,500.—by Steven H Leibson

**Zaxtek**, Irvine, CA, (714) 474-1170.

Circle No. 587

## PCI BUS CONFERENCE ISSUES CALL FOR PAPERS

Annabooks, a publisher and provider of information to designers of hardware and embedded systems, is sponsoring a new conference focusing on the technology and methods of designing, manufacturing, and marketing PCI-based components and computer systems. PCI '95, which EDN will co-sponsor, will take place April 5 to 7, 1995, in San Diego.

The organizer has invited participants to submit proposals in their areas of expertise for presentations, seminars, tutorials, or panels. Participants can also submit ideas for forums describing the problems and needs of manufacturers, distributors, value-added resellers, test engineers, product managers, software developers, and computer vendors. Topics of interest include bus design and compliance, comparisons with and bridging to other buses, market and sales trends, international markets, marketing methods, embedded applications, plug and play, PLDs, and more. Submit your proposals no later than Sept 30, 1994, to Dr Lance A Leventhal, Program Coordinator, PCI '95, Annabooks, 11848 Bernardo Plaza Court, Suite 110, Box 270708, San Diego, CA 92198-2708.—by Fran Granville

**Annabooks**, San Diego, CA, (619) 673-0870

Circle No. 588





# Precision light measurement without costly A/D converters.

Now there's a remarkably simple way to process a wide dynamic range of light levels — with the all-new TSL230 current-to-frequency converter from Texas Instruments.

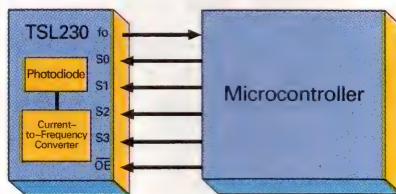
**A single, low-cost chip that's beyond measure.** TI extends your reach with the first opto device that offers you a high-resolution conversion of visible and near-infrared light into digital format — all on a single chip. Meaning you can eliminate the need for external op amps, A/D converters and discrete photodiodes.

The TSL230 is a monolithic combination of a configurable photodiode

#### TSL230 Technical Specifications

- 16-bit or 1 microsecond light-level measurement
- 160 dB input dynamic range
- Digitally programmable sensitivity
- 2.7- to 6-V operation
- 100 ppm/°C temperature coefficient
- 0.2% nonlinearity at 100 kHz
- \$2.76 each in quantities of 1,000

#### Simple Microcontroller Interface



and a high-resolution current-to-frequency converter packed into one cost-effective, clear-plastic 8-pin DIP. And it interfaces directly with your microcontrollers.

**Its performance attributes shine bright.** The TSL230 lets you reduce system cost and minimize design complexity in such applications as fluid opacity, light measurement and control, and industrial process controls.

**Want us to shed more light?** To learn more about the TSL230, simply circle the reader response number below.

E X T E N D I N G   Y O U R   R E A C H <sup>™</sup>

 **TEXAS  
INSTRUMENTS**





# SRAM EEPROM MASKROM



# Diverse features focused On One Point, Sophisticated Technology.

**Samsung creates new value  
from advanced memory technology.**



## SRAM

	DENSITY	ORG.	SPEED	PKG	REMARK
SLOW	64K	X8	70/100/120	28DIP/SOP, 28SDIP	
	256K	X8	(55/70/85/100/120	28DIP/SOP, 28TSOP (I)	55ns, 3.0V:2Q '94
	512K	X8	55/70/100	32SOP, 32TSOP (I)	
	1M	X8	55/70/85/100/120	32DIP/SOP, 32TSOP (I)	3.0V:2Q '94
	4M	X8	45/55/70/100	32DIP/SOP, 32TSOP (II)	3.0V AVAILABLE
FAST	64K	X4	15/20/25	22DIP, 24SOJ	
		X8	15/20/25	28DIP/SOJ	
	256K	X4, X8	6/7/8 (BICMOS)	28, 32SOJ	CENTER PWR
		X4, X8	8/10/12 (BICMOS)	28SOJ	CORNER PWR
		X4, X8	(12/15/20/25	28SOJ	12ns:2Q '94 3.3V/15ns:3Q '94
	288K	X9	9/10/12 (BICMOS)	32SOJ	
		X4, X8	20/25	32SOJ, 36SOJ	
	4M	X16	20/25	44SOJ	
		X4, X8	8/9/10/12 (BICMOS)	32SOJ	
		X4, X8	20/25/35	28DIP/SOJ, 32DIP/SOJ	CORNER PWR
		X4, X8	15/20	32SOJ	CENTER PWR
	1M	X16	15/17/20	44SOJ	CENTER PWR
		X4, X8	15/17/20	44SOJ	
SPECIALTY	1M	64KX18 (S.B)	8/9/10/12	52PLCC	P5 CACHE
		256KX4 (S.P)	10/12.5	36SOJ	MIPS R 4000/R 4400



## MASK ROM

DENSITY	PART NO.	ORGANIZATION	SPEED(ns)	PACKAGE
256K BIT	KM23C256X	32K X 8	120/150	28DIP/32SOP
512K BIT	KM23C512X	64K X 8	120/150	28SIP/32SOP
1M BIT	KM23C10XX SERIES	128K X 8	120/150	28DIP/32DIP/32SOP
2M BIT	KM23C2X0X SERIES	256K X 8	100/120	32DIP/32SOP/40DIP
		126K X 16		
4M BIT	KM23X4X0X SERIES	512K X 8	100/120/150	32DIP/32SOP/40DIP/40SOP
		256K X 16		
8M BIT	KM23X8X0X SERIES	1M X 8	100/120	32DIP/32SOP/42DIP/44SOP
		512K X 16		
16M BIT	KM23X16X0X SERIES	2M X 8	120/150	42DIP/44SOP/36DIP
		1M X 16		
32M BIT	KM23C32X0X SERIES	4M X 8	150/200	42DIP/44SOP/70SSOP
		2M X 16		



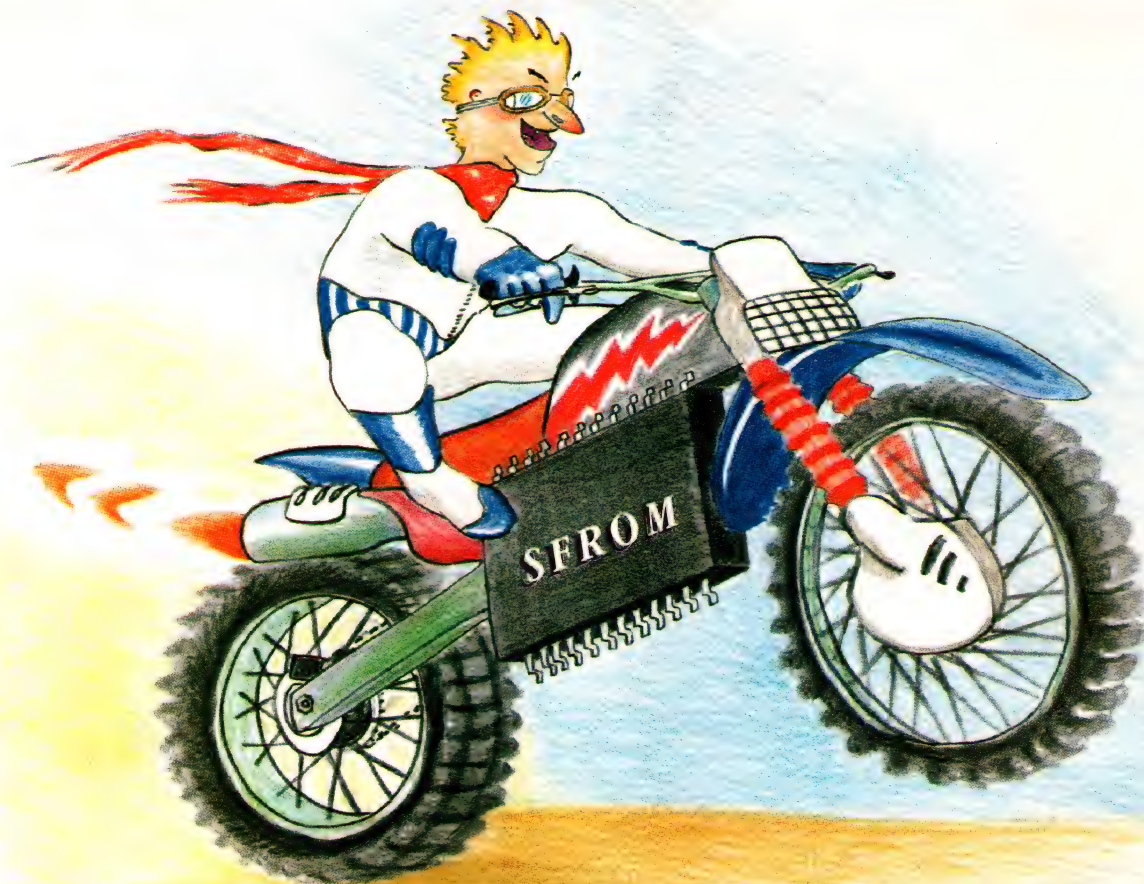
## EEPROM/FLASH

DENSITY	PART NO.	ORGANIZATION	SPEED(ns)	PACKAGE
256 BIT	KM93C06/07	16 X 16	1 MHz	8DIP/8SOP
1K BIT	KM93C46 SERIES	64 X 16	1 MHz	8DIP/8SOP
2K BIT	KM93C56 SERIES KM93C57 SERIES	128 X 16	1 MHz	8DIP/8SOP
		128 X 16	1 MHz	8DIP/8SOP
		256 X 8	1 MHz	8DIP/8SOP
4K BIT	KM93C66 SERIES KM93C67 SERIES	256 X 16	1 MHz	8DIP/8SOP
		256 X 16	1 MHz	8DIP/8SOP
		512 X 8	1 MHz	8DIP/8SOP
	KM28C16/J/I KM28C17/J/I	2K X 8 2K X 8	150/200/250 150/200/250	24DIP/32PLCC 28DIP/32PLCC
64K BIT	KM28C64A SERIES KM28C65A SERIES	8K X 8 8K X 8	120/150/200 120/150/200	28DIP/32PLCC 28DIP/32PLCC
1M BIT	KM29C010/J/T	128K X 8	100/120/150	32DIP/PLCC/TSOP
16M BIT	KM29N16000T	2M X 8	80	44(40)TSOP (II)

TECHNOLOGY  
THAT WORKS  
FOR LIFE







# Easy riding *with* SFROM<sup>TM</sup> !

*The fastest way from design to production*

Tired of EPROM's erasing nightmare ?

Challenged by Flash's in-circuit updatability ?

Hampered by EEPROM's limited capacity ?

Smart Flash ROM (SFROM) is the optimal re-programmable device for non-volatile memory that enables quick and easy continuous write and rewrite without removal and without UV erase.

SFROM is the only re-programmable device for non-volatile memory that incorporates large flash storage capacity *plus* in circuit remote re-programming capability with absolutely no design efforts.

## SFROM incorporates:

- 256 Kbit to 16 Mbit flash memory
- Self-loading peripheral memory for firmware and/or data storage
- In circuit self re-programmability
- On-chip UART for serial interface
- I<sup>2</sup>C standard Interface

Call or fax:



- **Headquarters: EUROM FlashWare Solutions Ltd.**  
Atidim Industrial Park Bldg. 1, P.O.B 58032, Tel Aviv 61580, Israel  
Tel: +972-3-490 920 Fax: +972-3-490 922
- **USA Office: EUROM FlashWare Solutions Inc.**  
4655 Old Ironsides Drive, Suite 200, Santa Clara, CA 95054  
Tel: 408-748-9995 Fax: 408-748-8408



## Reader adds more pieces to simulation puzzle

Regarding "System simulation embraces real-time control prototyping" (EDN, May 26, 1994, pg 49) by Senior Technical Editor Brian Kerridge, while we at Applied Dynamics International (ADI) agree with its basic premise, it appears that the author failed to do his homework. Of the 10 companies listed on pg 56, only two are common names in the real-time system-simulation arena. The article missed several legitimate vendors, for instance ADI, Xanalog, and Harris.

Secondly, the article implies that the only way to perform system simulation is by utilizing "a DSP test bed." The 32-bit DSP represents the low end of compute power in price/performance for complex system simulation. The DSP is totally inadequate for the level of numerical integration accuracy required in simulating very stiff systems—those characterized by a broad range of frequency content. Today's RISC technology, which can handle both 32- and 64-bit computations, is a far better choice of compute power for those who are serious about doing simulation jobs properly.

Mr Kerridge also states that "Increasing system power is simply a matter of installing more DSP hardware, and all systems include multiprocessing expansion for this purpose." Although most systems do support multiple processors, utilizing multiple processors can be very cumbersome if the system supplier doesn't supply easy-to-use software tools for handling multiple numerical integration frame rates, intra- and interprocessor communications, multiprocessor/multilanguage (Fortran and C) symbolic debugging, etc. Moreover, using multiple processors doesn't guarantee a solution. Adding more processing power is the easy part; being able to do something *useful* with the additional compute power is where the fun begins!

ADI has been providing real-time simulation systems since 1957. We have a reputation for solving the most demanding simulation problems. We have recently teamed with Boeing

Computer Services and General Electric to provide the most comprehensive set of systems engineering tools available—including integrated rapid prototyping tools.

*Robert L Goffee  
Applied Dynamics International  
Ann Arbor, MI*

## Sound off

Send your letters to Signals and Noise Editor, EDN, 275 Washington St, Newton, MA 02158. Or fax us at (617) 558-4470. EDN reserves the right to edit letters for clarity and length.

### 800 Series

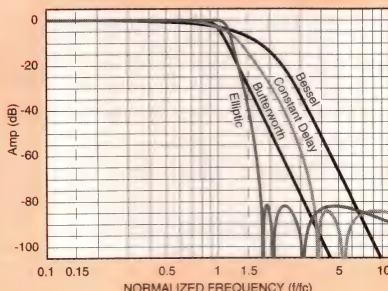
## ELECTRONIC FILTER MODULES Digitally Programmable

- Anti-Alias
- Noise Elimination
- Signal Reconstruction

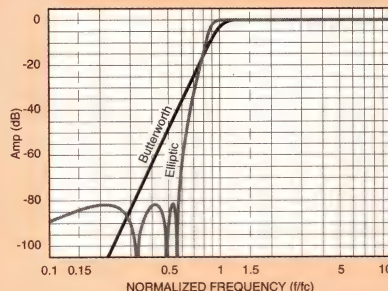
- 256 digitally programmable steps allow selecting cutoff frequencies specific to each application.
- 6 available tuning ranges up to **100 kHz** mean precision performance with maximum design flexibility.
- Fully finished, plug-in filters reduce project design cycles while providing cost-effective filter solutions.
- 4-pole models are also available.



Available 8-Pole  
Low-Pass Frequency Response



Available 8-Pole  
High-Pass Frequency Response



**FREQUENCY  
DEVICES™**

Call Us Today at  
**(508) 374-0761**

25 Locust Street • Haverhill, MA 01830 • FAX (508) 521-1839

CIRCLE NO. 4

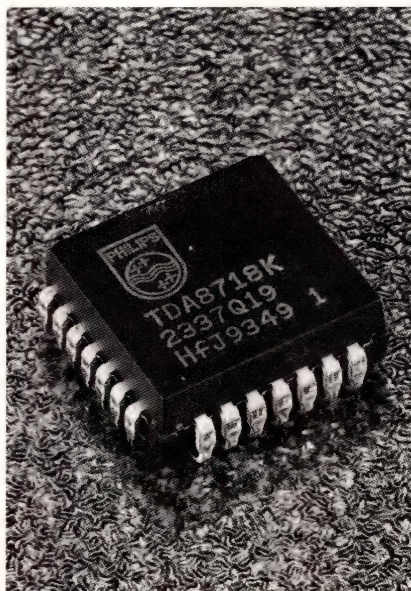


For more information on any of these subjects: call 1-800-447-1500 and request appropriate extension number.

Europe – use EDN Information Retrieval Service or contact us direct via fax on +31 40-724825.

All Philips Semiconductors plants worldwide are ISO 9000 certified

## Ultra-fast 8-bit A/D converter provides unique performance



*The TDA8718 provides a unique combination of very high sample rate, wide input bandwidth and low power consumption.*

Capable of digitizing an analog signal at up to 600 Msamples per second while maintaining an effective 8-bit signal bandwidth of 150 MHz, the new TDA8718 8-bit high-speed A/D converter is designed for use in professional applications such as disk drives, digital storage oscilloscopes, digital radio receivers and satellite

communications equipment. Its very high sample rate gives it a usable input bandwidth of 150 MHz, while its low power dissipation of only 1 W helps to reduce overall power consumption.

The TDA8718's wide input bandwidth and excellent dynamic performance are made possible by a specially-designed analog input stage which reduces the input capacitance to a mere 5 pF and eliminates the need for external sample-and-hold circuitry for input signals up to 150 MHz. To allow the input range to be adjusted to suit different analog signal amplitudes, both ends and the center point of the on-chip 48  $\Omega$  reference divider ladder are led out to device pins. This allows the input amplitudes corresponding to digital zero and digital full-scale to be easily set by an external voltage reference.

The A/D conversion results in 8-bit binary coded data, plus separate overflow and underflow flags, which appear at ECL-100k-compatible outputs that can drive 50  $\Omega$  loads. The TDA8718 operates from a -4.5 V supply and has an operating temperature range of 0 to +70°C.

Call 1-800-447-1500 Ext 1135  
Europe: circle no. 40

## Single-ended silicon microwave transistor delivers 60 W

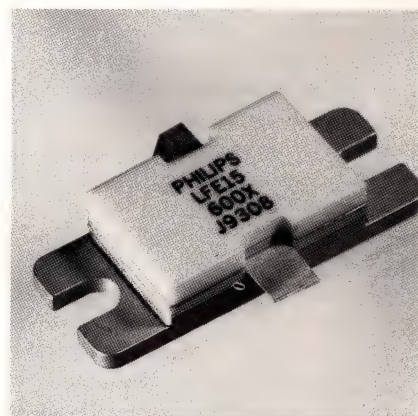
The LFE15600X silicon npn microwave power transistor is the first single-ended 60 W device suitable for use in the class AB output stages of transmitters operating in the 1.5 to 1.7 GHz frequency band.

The LFE15600X's single-ended base input, plus its high power handling and diffused emitter resistors, allow transmitter powers of several hundred watts to be achieved by connecting a number of the devices in parallel, without the need for complex input-matching circuitry. The device's very low level of third-order intermodulation distortion, typically

better than -30 dBc at 60 W PEP, suits it for use in multi-carrier transmitters such as those found in PCS/PCN base stations, as well as in transmitters for mobile satellite communications.

The transistor achieves a typical full-power collector efficiency of 50% at a junction temperature of 100°C which results in lower operating temperatures and excellent long-term reliability. Typical power gain is 8.5 dB at 1.5 GHz, permitting simpler driver stage design.

Call 1-800-447-1500 Ext 5016  
Europe: circle no. 41



*The LFE15600X microwave power transistor is housed in an FO-231 metal/ceramic flanged package.*

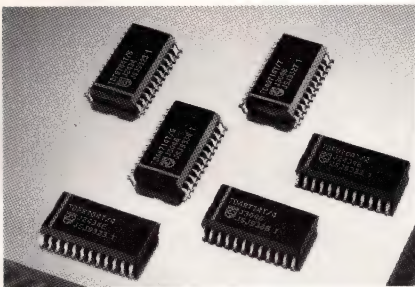


## High-speed 8-bit A/D converters are ideal for low-voltage, low-power applications

Two new high-speed 8-bit A/D converters have been introduced for use in video signal processing, transient/pulse analysis and general industrial applications. Both converters operate from 5 V supplies and only dissipate around 350 mW, making them ideal for applications requiring non-multiplexed multi-channel A/D conversion coupled with low overall power consumption.

The TDF8704, which has the  $-40$  to  $+85^{\circ}\text{C}$  operating temperature range required for automotive and industrial applications, digitizes at up to 50 Msamples per second. Sampling a 4.43 MHz full-scale analog input at this rate, it achieves 7.4 effective bits. Total harmonic distortion is typically  $-60$  dB and its usable input bandwidth extends to 10 to 15 MHz. Designed for stand-alone operation, the TDF8704 has a stable on-chip voltage reference with low drift with respect to both temperature and supply voltage.

The TDA8714, which is designed for professional applications in areas such as video, radar, medical imaging and research physics, operates with external voltage reference inputs that set the analog input range. It has a higher



*The TDF8704 and TDA8714 high-speed A/D converters are housed in 24-lead SO packages. The TDA8714 will also be available in the 24-lead shrink small outline plastic (SSOP) package.*

sampling rate of 75 Msamples per second which allows it to achieve 7.7 and 7.3 effective bits respectively for input signals of 4.43 and 10 MHz. The TDA8714 is still effective at digitizing input signals as high as 15 to 20 MHz.

The ICs are also available in lower speed versions with sample rates of 40 or 20 Msamples per second for the TDF8704 and 60 or 40 for the TDA8714.

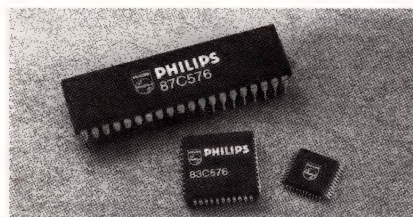
**Call 1-800-447-1500 Ext 1136**  
**Europe: circle no. 42**

## Feature-packed 80C51 offers highest integration level and system reliability

The latest addition to Philips Semiconductors' wide range of 80C51-based 8-bit microcontrollers is the most feature-packed on the market. The 8XC576 offers a highly integrated controller with UPI (Universal Peripheral Interface) and a 10-bit A/D converter, simplifying board design and eliminating the need for external components. The device improves system fault tolerance with low electromagnetic and RF emissions.

The 8XC576 addresses a broad range of applications including automotive and industrial control, data communications, instrumentation, medical electronics, computers and peripherals and cellular/wireless networks. By demonstrating greatly reduced EMI/RFI emissions, the 8XC576 ensures easier compliance with EU and FCC standards; while exact savings are application dependent, the new microcontroller has reduced emissions by more than 20 dB in some designs.

Additional features of the 8XC576 include: 8 kbytes of ROM (83C576) or EPROM



*The 8XC576 8-bit microcontroller is the most feature-packed 80C51 derivative on the market.*

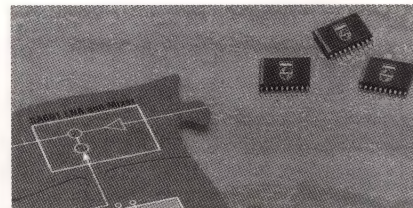
(87C576), 256 bytes of RAM, three 16-bit counters/timers, programmable counter array, on-chip watchdog timer, analog comparators, enhanced UART, two PWM outputs, power and oscillator fail detection, user-programmable outputs and Schmitt trigger inputs. The 8XC576 is software-compatible with earlier 80C51 derivatives and packaging options include plastic and ceramic dual-in-line package and leadless chip carrier.

**Call 1-800-447-1500 Ext 1137**  
**Europe: circle no. 43**

## New RF front-end IC reduces cost and complexity of 900 MHz wireless designs

The new low-voltage SA601 RF IC integrates all the front-end functions needed for a variety of 900 MHz wireless receiver applications. It offers benefits of simplified design, small size, low power consumption and low cost to system designers.

The SA601 incorporates a low noise amplifier (LNA), down-convert mixer, local oscillator buffer and temperature and supply voltage compensating bias circuitry in one small 20-lead SSOP surface-mount package. Total current draw is only 7.4 mA at 3 V. The SA601 provides a complete RF receiver front-end solution for American and European analog and digital cellular phone applications (AMPS, TACS, IS-54 and GSM) and 900 MHz cordless phone applications (CT1 and CT2) as well as spread spectrum receivers in the 902-928 MHz Industrial, Scientific and Medical (ISM) band. It is also available as part of a low-voltage TDMA IS-54 digital cellular chipset that combines all the necessary RF and IF functions (LNA/mixer, Fractional-N synthesizer, monolithic digital IF receiver and multifunction



*The SA601 addresses a large and growing market for low-voltage RF receivers in everything from cellular phones to remote control units.*

transmit modulator/synthesizer) in four chips.

The SA601 delivers high performance with low power consumption. Its LNA has a noise figure of 1.6 dB and a power gain of 11.5 dB at 900 MHz. The active mixer provides an additional 6 dB of conversion power gain with a noise figure of 10 dB at 900 MHz. LNA and mixer performance is exceptionally stable in fluctuating temperature and supply voltage (5.5 to 2.7 V) conditions, making the IC an excellent choice for mobile telephones.

**Call 1-800-447-1500 Ext 1138**  
**Europe: circle no. 44**



# PHILIPS





# *FAST* Track to *FAST* SCSI

**90's Challenges.** The 90's demand higher levels of performance and faster delivery than ever. Time-to-market, technological demands, and changing user needs make fast, simple SCSI seem as elusive as the horizon. To stay ahead in these challenging times, you need products you can count on, with proven ability to deliver the quality and reliability your customers require.

**90's Products.** After over a decade of industry leadership, NCR is still working hard to meet your needs and the challenges of the 90's. The NCR 53C90 family of SCSI Controllers is constantly evolving, implementing and offering state-of-the-art products. For example, the NCR 53C90 family supports multiple bus architectures, advanced SCSI-2 commands, fast SCSI data transfers and provides our exclusive TolerANT® SCSI driver and receiver technology, for reliable data transfers in every SCSI system.

**90's Solutions.** The SCSI challenges of the 90's can't be solved with silicon alone. NCR quality and service provide you with the competitive edge that can make your industry leading designs a reality. Whether you require SCSI-1 or fast SCSI-2, in any system architecture, NCR has the product to meet your needs today. You can count on to keep you on the fast track with the right technology, at the right price, at the right time for all your SCSI requirements.

## The NCR 53C90 Family

*Proven Performance  
for the 90's and  
Beyond*

CIRCLE NO. 91

**NCR SCSI: Real Products, Real Solutions, Real Fast!**

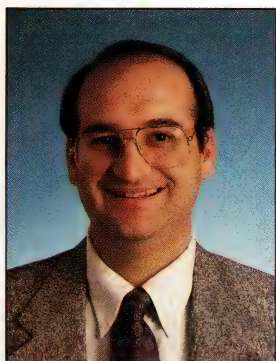
SCSI	FAST SCSI*	
53C90A	53CF90A	Single-bus architecture; SCSI sequences controlled by hardware state machine to minimize host intervention
53C90B	53CF90B	Adds pass-through parity for increased system reliability
53C94	53CF94	Adds split-bus architecture for more flexibility
53C96	53CF96	Adds support for differential transfers

\*NCR Fast SCSI devices transfer SCSI data at 10 MB/s synchronous or 7 MB/s asynchronous

*For more information about  
NCR SCSI products  
and a free poster,  
call 1-800-334-5454.*







## Twenty-five years

The universe arranged a giant fireworks show to commemorate the 25th anniversary of the Apollo 11 moon landing. A string of at least 21 rocky fragments, formerly known as Comet Shoemaker-Levy 9, bombarded Jupiter during the same four days (July 16 to 20) when Apollo 11 journeyed to the moon 25 years ago. We can see images of the incredible devastation wreaked upon Jupiter because of some terrific space hardware developed in the intervening years.

**We can go back to the moon any time we want.**

First, there's the Hubble Space Telescope, recently refurbished during a spectacular space-shuttle mission and eagerly trained on Jupiter. I watched a tape of the Hubble team as they viewed the first image returned by the telescope. The picture from Hubble showed several dark pixels marking the first impact spot on Jupiter. The team became ecstatic when they saw the assembled image, and several team members celebrated by swigging more than a little champagne on screen. Subsequent images of the impact results were even more exciting. Photos from the Keck telescope on Mauna Loa in Hawaii show a great blister raised in Jupiter's atmosphere by some of the fragments.

The comet fragments impacted Jupiter on the side of the planet facing away from the Earth, so we had to wait until the planet rotated the resulting wounds into view. We do, however, have another viewing platform

in space. Space Probe Galileo is en route to Jupiter, and it can see the part of the planet being struck by the comet fragments. I have not seen the images as I write this editorial on the anniversary of the moon landing (July 20), but I'm sure the pictures will be spectacular. Meanwhile, impacts so far have already triggered huge electrical storms on Jupiter.

The point of all this is to say that we have indeed made significant progress in our space efforts since Apollo. True, we cannot return to the moon today, a situation many bitterly lament. I don't. We certainly retain the technology to go to the moon. All we need is the will to make the trip, and space has proven an irresistible lure to the curious. In the last few years, we've launched and fixed Hubble; we've flown Clementine, an econoprobe that has completely mapped the moon for the first time; and we've built and test-flown the DCX, an experimental single-stage-to-orbit rocket based on 1990s technology instead of Apollo's 1960s hardware or the space shuttle's 1970s hardware. We can go back to the moon any time we want. And we will.

*Steven H. Leibson*

**STEVEN H. LEIBSON**  
EDITOR-IN-CHIEF



**Jesse H. Neal**  
Editorial Achievement Award  
1990 Certificate, Best Editorial  
1990 Certificate, Best Series  
1987, 1981 (2), 1978 (2), 1977,  
1976, 1975

**American Society of**  
Business Press Editors Award  
1994, 1991, 1990, 1988, 1983,  
1981

Send me your comments via fax at (617) 558-4470, or on the EDN Bulletin Board System at (617) 558-4241, 300/1200/2400 8,N,1. From the Main System Menu, enter ss/soapbox and select W to write us a letter.



7.5ns



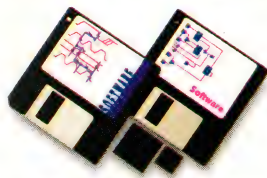
# Nanoseconds Alo How AMD Has Impro

The New MACH® Family Gives You 7.5ns Speeds,  
Plus The Design Tools You Need To Get To Market Faster.

You can never be too fast.

Or too well equipped, for that matter. And the new MACH CPLDs give you both: The speed you need for the critical path — up to 7.5ns. Plus a whole new set of design tools you'll need along the way.

There's nothing faster than the new members of our MACH family. Our 1800-



*The new MACH family members feature speeds up to 7.5ns, while our new software tools include schematic design entry and timing simulation capabilities.*

gate MACH 210A-7 clocks-in at 7.5ns, while our 3600-gate MACH 230-10 reaches 10ns. Now that's fast.

And you'll bring your product to market in record time with AMD's new software offerings. Now you can get your favorite design tools — including MicroSim, Data I/O® and Viewlogic™ — directly from AMD®





# ne Can't Measure ved The MACH Family.

You get the right tools, right away.

If you need additional design support, you can always rely on our FusionPLD<sup>SM</sup> partners, a team of vendors ready and waiting to give you the support you need when speed is of the essence.

What's more, AMD delivers both JTAG testing and 5-Volt in-circuit programming. So you have the flexibility to test, program, and reconfigure your designs right on the board. And both capabilities are an integral part of our free in-circuit programming kit.

So contact your local AMD sales office listed

below for more information on the entire high-speed MACH family, design tools, and our free 5-Volt in-circuit programming kit. Because with AMD behind you, you'll finish faster every time.



Ask for our free  
programming  
kit 19Q.



## Advanced Micro Devices

For more information on the MACH family, contact your local AMD sales office or sales representative. International Sales Offices: Antwerpen (031 248 43 00); Frankfurt area (06172) 9267-0; Hong Kong 86 54 525; London area (0483) 740 440; Manchester area (0925) 830 380; Milano (02) 339 05 41; München (089) 45053-0; Osaka (06) 243 32 50; Paris (11) 49 75 10 10; Seoul (02) 784 0030; Singapore (65) 348 11 88; Stockholm (08) 98 61 80; Taipei (02) 715 35 36; Tokyo (03) 334 67 550.

EDN September 1, 1994 ■ 31



# *Setting the Standard*







*Actual size*

Sales of color notebook PCs are soaring and better displays have a lot to do with the growth. NEC designed the 24cm (9.4-inch) Thin-Film-Transistor LCD for the world's first color notebook. Now the 24cm screen has become the de facto standard.

Our 24cm TFT active-matrix LCDs offer 4,096 colors with 640 x 480 pixels. They provide luminance of 90 cd/m<sup>2</sup>, consume 5W, measure 12.5mm deep and weigh only 680g. Designers agree that they offer an optimum balance between luminance, power consumption, dimensions and weight.

For a display that adds value to notebook, call NEC today.

CIRCLE NO. 121

**NEC**



# ***Upsetting the Standard***



*Actual size*



CRTs have been the standard for PCs, workstations and measuring equipment. But designers of high-end products are now demanding more sophisticated displays.

NEC's high-integration technology has arrayed 640 x 480 pixels on a 17cm (6.5-inch) screen at an ultra-fine pixel pitch of 0.207mm. Our new 17cm LCDs offer 4,096 colors, provide luminance of 120 cd/m<sup>2</sup>, consume 5W, measure 12.5mm deep and weigh only 360g. Never has so much resolution been offered on a screen so small.

Designers have already started using our flat, high-resolution color screens to attract end-users. We think there's a new standard in the making.

NEC concentrates on high-end displays that add value to your system. We're committed to TFT active-matrix color LCDs because the technology offers clear advantages in display quality and performance. If you want to display your commitment to quality, call NEC today.

---

**The right components to build your reputation.**

---

**For fast answers, call us at:** **USA** Tel: 1-800-366-9782, Fax: 1-800-729-9288. **Germany** Tel: 0211-650302, Fax: 0211-6503490.  
**The Netherlands** Tel: 040-445-845, Fax: 040-444-580. **Sweden** Tel: 08-753-6020, Fax: 08-755-3506. **France** Tel: 1-3067-5800, Fax: 1-3946-3663.  
**Spain** Tel: 1-504-2787, Fax: 1-504-2860. **Italy** Tel: 02-6709108, Fax: 02-66981329. **UK** Tel: 0908-691133, Fax: 0908-670290. **Ireland** Tel: 01-6794200,  
Fax: 01-6794081. **Hong Kong** Tel: 886-9318, Fax: 886-9022. **Taiwan** Tel: 02-719-2377, Fax: 02-719-5951. **Korea** Tel: 02-551-0450, Fax: 02-551-0451.  
**Singapore** Tel: 253-8311, Fax: 250-3583. **Australia** Tel: 03-8878012, Fax: 03-8878014. **Japan** Tel: 03-3798-6148, Fax: 03-3798-6149.

CIRCLE NO. 122

**NEC**



▼

**MIXED-SIGNAL SIMULATORS NOW OFFER LANGUAGES  
THAT EXTEND THE DIGITAL DESIGN LANGUAGES OF  
VHDL AND VERILOG TO ANALOG DESIGN.  
THE OPTION TO USE ANALOG BEHAVIORAL DESCRIPTIONS  
SIMPLIFIES DESIGN AND INCREASES  
SIMULATION SPEED.**





# MIXED ANALOG-DIGITAL SIMULATION

DOUG CONNER, TECHNICAL EDITOR

THE MORE COMPLEX YOUR DESIGN, THE GREATER the chance that some parts of the system won't function properly together or function in all cases. Simulation provides designers with a way to test designs and verify a system before building the hardware.

The standards for modeling digital designs are VHDL, Verilog, and gate-level schematic design. For analog, the standard is Spice. Now, extensions to VHDL and Verilog extend the hardware description languages (HDLs) to analog design. Although the standards aren't finalized, products are emerging. You can describe your designs at any level from transistors through behavioral descriptions for both analog and digital. Simulating a mixed-signal system now offers many options.

Understanding mixed-signal simulation starts with first understanding the problems these simulators must face. How well a simulator works often depends on how effectively the manufacturer addresses the problems. Two key concerns characterize the mixed analog-digital simulation problem. The first is the speed of analog simulation: Transistor-level simulations run slowly in comparison with digital simulations with the same number of transistors. The problem centers around the greater number of equations that the simulator must evaluate for the same number of transistors compared to a digital simulator. Behavioral-level analog models can help speed up circuit simulation by reducing the number of equations that must be evaluated.

PHOTOGRAPH COURTESY CADENCE DESIGN SYSTEMS



## MIXED ANALOG-DIGITAL SIMULATION

The second problem with mixed analog-digital simulation occurs when tying analog and digital simulators together. Although some simulators such as Analog's Saber and MicroSim's PSpice provide a native mixed-signal capability, these simulators are aimed primarily at analog circuits with moderate numbers of digital gates. For mixed-signal circuits containing large numbers of digital gates, such as ASICs, standard digital simulators usually prove more effective. For this reason, most analog simulators intended for mixed-signal applications, even those with a native mixed-signal capability, provide interfaces that connect to the mainstream digital simulators.

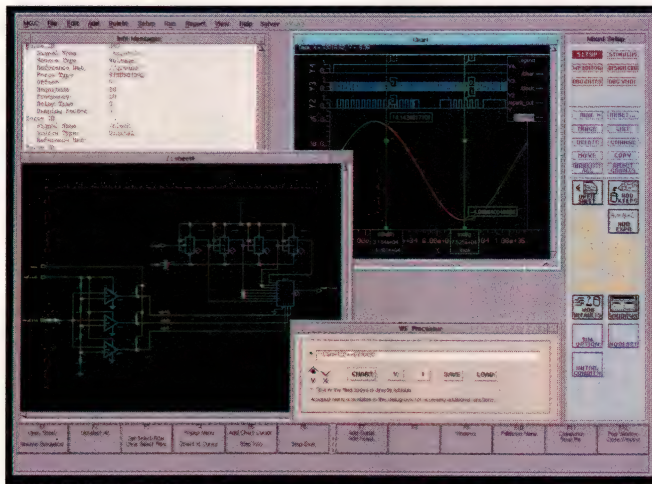
Tying analog and digital simulators together presents two problems. First, the simulators must pass information back and forth, but they generally do not run with the same time increments. Digital simulators jump between state changes, usually referred to as events. In the digital domain, only state changes have significance; in the analog domain, time steps normally won't match the digital simulator. To pass data back and forth between the analog and digital simulators, manufacturers can synchronize the two simulators using different approaches.

A simple—but not necessarily efficient—method is to lock the two simulators' time steps together so that analog and digital simulators evaluate signals at every digital time step. This approach usually proves inefficient because the analog simulator needs to evaluate more time steps and slows the whole simulation.

Another approach typically used for simulation backplanes involves synchronizing the analog signal at some periodic rate. Depending on the periodic rate, the potential for analog-simulation error occurs if the period is too large. A too-small period results in slowed performance.

You could also let the two simulators run free and synchronize events only when data must be exchanged. This method works well except that one simulator may get ahead of the other, caus-

ing the analog simulator to require backtracking to a previous value. The simulator can backtrack either by using additional simulation or by using stored values from previous time increments.



**Integrated mixed-signal simulators, such as Continuum from Mentor Graphics, let you view analog and digital waveforms on the same display, simplifying design verification.**

Although any of the above methods will synchronize analog and digital simulators, the particular method used can affect the accuracy and simulation time. You should keep this in mind when you evaluate mixed-signal simulators.

Another problem in tying the analog and digital simulators together occurs when modeling the signals that interface between the analog and digital portions of the simulation. Although Boolean states work well for a digital simulator, an analog simulator requires more information to accurately model the signal. Treating an analog-to-digital transition as a comparator and a digital-to-analog transition as a switch works fine for a first cut at modeling a system. But for accurate results, you need more detailed models. The model may need to include output loading, nonlinear input parasitics, and input thresholds. The characteristics depend on the family of the digital circuits such as TTL, MOS, and ECL. Even within a particular family of digital devices, different devices may contain different characteristics, such as output drive.

The industry hasn't developed any standards for interfacing analog and digital models. So, when you evaluate different mixed analog-digital simulators, you may want to look into the details of how each handles the com-

munication between the analog and digital simulators. Analog, for example, developed a set of special models, called Hypermodels, for its Saber simulator that take care of the translation between analog and digital. The simulator automatically inserts the appropriate models between analog and digital parts.

Assuming you addressed synchronization and communication problems using a mixed-signal simulator, your greatest concerns remain specifying your design and simulation speed.

HDLs and top-down design methods, well known in the digital world, are also available in the analog design world. Lack of standards and lack of a pressing need has probably kept many designers from using them.

Previously you could specify a system at a high level, but you needed to use a proprietary language designed for simulation, which lacked portability. Or, you needed to use a standard software language, such as C, which contained the flexibility but lacked models for analog simulation.

For the designer already comfortable with using Verilog or VHDL for creating descriptions of digital hardware, another language for analog behavioral descriptions with new syntax and other software-specific idiosyncrasies provides an unwanted burden. Although Spice reigned supreme for years as the analog modeling language, and will undoubtedly figure prominently for years to come, mixed-signal designers who work simultaneously in both the digital and analog world need something to simplify their work and make them more efficient.

Proponents of VHDL and Verilog continue to battle for their cause, and because both languages have a popular foothold in the electronic design community, they will probably exist for some time. Consequently, any mixed-signal simulation language needs to work with both languages, unless the manufacturer wants to cut itself out of a significant segment of the electronic simulation market.

Although you could use analog



behavioral languages for some time, VHDL-A and Verilog-A are the first languages that attempt to bring analog and digital HDLs together. In the past, the languages used for the analog and digital portions of a design were either completely different or proprietary and focused toward the analog designer. Given a choice, you probably wouldn't write half a program in C and half in Fortran. The analog extensions to VHDL and Verilog help alleviate the multiple-language problem.

Top-down design provides a smooth path from initial specification through physical layout. Certainly, many spots in the path can trip you up. On the digital side, behavioral logic synthesis is just becoming available, but only for DSP and other specialized types of systems. You usually need to reduce your behavioral HDL design to the register transfer level (RTL) before logic-synthesis tools can implement the design. Timing problems may come back again to haunt you at the layout stage.

In the analog world, top-down design lacks even more steps. Presently, only a few specialized tools can synthesize analog designs from behavioral-level descriptions. These tools tend to exist for filter design and related functions. VHDL-A and Verilog-A set standards for hardware descriptions that may eventually result in the growth of analog synthesis tools. However, their utility is aimed at helping out with system specification and simulation. You'll need to eventually translate the behavioral hardware description into a functional circuit description suitable for implementation at the board or IC level.

Having compatible HDLs for analog and digital provides a consistent method for specifying complex systems. With Verilog and VHDL as the leading standards for digital HDLs, the analog extensions should provide the easiest way for designers to describe the

analog parts of a system for a combined analog-digital simulation.

Although Analogy, Anacad EES, and Mentor Graphics announced simulators compatible with the VHDL-A stan-

dards involved maintain they will continue to upgrade the tools to maintain compliance as the languages evolve.

Maintaining compatibility with a language that does not contain formal definition may sound risky, but the risk probably isn't too great. Standard syntax conventions for VHDL and Verilog remain well established and the companies can adhere to these. Although changes to the functions may present a problem for models, adding new functions to simulators should be fairly easy. Depending on how great the changes are as the languages evolve, users may need to spend some time upgrading models to maintain compatibility with an evolving standard.

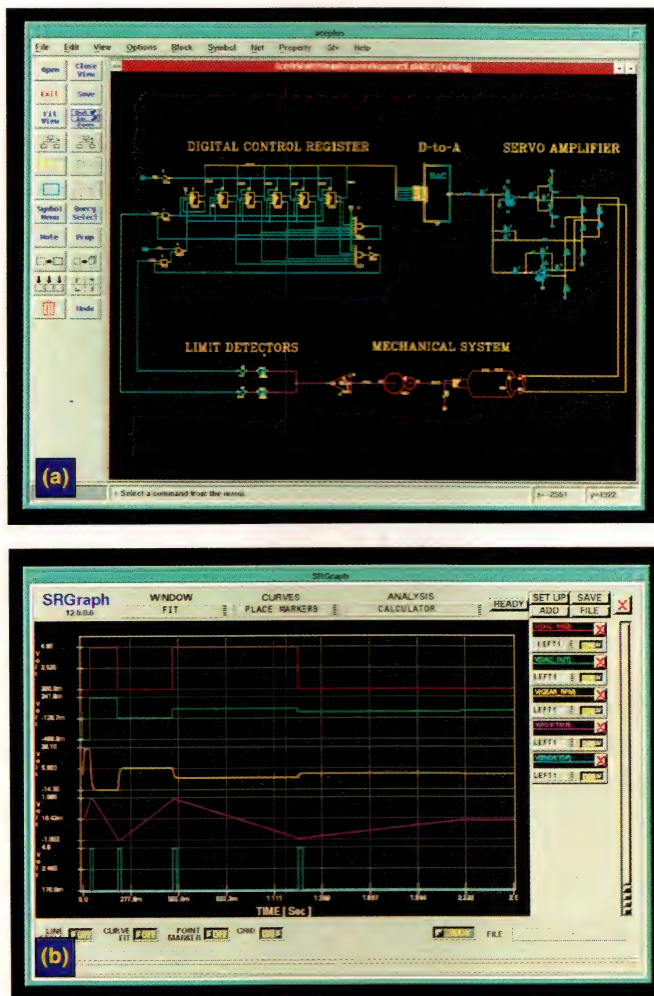
Although it sounds risky to use tools trying to meet a yet-undefined standard, the benefits outweigh the risks. First, the HDLs speed up design by letting you specify the design at a higher level. Digital HDLs show significant time savings on large designs, and designers of analog systems can expect a time savings, also.

Second, the behavioral models speed up simulation. According to Cadence, Spectre HDL can speed up simulation by a factor of 10 to 100× or more depending on the level of behavioral modeling used. Some of the benchmarks Cadence ran on designs show simulation

time dropping from hours to minutes or even seconds. These reductions in simulation time can save a significant amount of time in the product development phase.

Although an analog HDL design can run more than 100× faster than an equivalent Spice simulation, it may not provide the detail you need. Although you can create an HDL model that simulates just as accurately as a Spice model, most models probably won't be taken to that level of detail. At some time during the verification of a design,

(continued on pg 44)



**The control circuit and mechanical system for a bar-code reader (a) combines gate-level, behavioral-level, transistor-level, control system, and mechanical models. Intergraph's Apex simulator (b) shows the analog and digital signals from simulation.**

dard, Spectre HDL from Cadence remains the first analog simulation language to accept both VHDL-A and Verilog-A for mixed-signal simulation. The two languages are both proposed extensions to digital HDLs. VHDL-A, under development with a language reference manual (LRM) to define the standard, is expected around the end of 1994. Cadence submitted Verilog-A as a proposed LRM to the Open Verilog International (OVI) organization. Changes to the languages will undoubtedly occur since neither language exists as a true standard. However, all of the ven-




## REPRESENTATIVE MIXED-A/D SIMULATORS

Company	Product	Price	Simulation capability	Computer and operating system
<b>Altium/IBM</b> Circle No. 301	AUSSIM	\$25,000	Digital and mixed-signal	Workstations
	SpecSim	\$50,000	Analog	Workstations
<b>Anacad EES</b> Circle No. 302	VHDeLDO	\$36,000	Mixed A/D	Workstations
<b>Analogy</b> Circle No. 303	Saber	\$20,000	Mixed A/D	Workstations
<b>AT&amp;T</b> Circle No. 304	ATTSIM	\$65,000 to \$75,000	Mixed A/D	Workstations
<b>Cadence</b> Circle No. 305	Spectre	\$30,000	Spice compatible	Workstations
	Spectre HDL	\$10,000	Analog behavioral modeling	Workstations
	Spice+	\$5000	Analog	Workstations
<b>Compass Design Automation</b> Circle No. 306	Navigator, mixed-signal design option	\$40,000	Mixed A/D	Workstations
<b>Contec Microelectronics USA</b> Circle No. 307	ContecSpice	\$5000	Mixed A/D	Workstations and PCs
<b>Dolphin Integration</b> Circle No. 308	Smash Standard	\$6500	Mixed A/D	Workstations, Windows, Macintosh
<b>Epic Design Technology</b> Circle No. 309	Timemill	\$69,640	Mixed A/D	Workstations
	Powermill	\$77,100	Mixed A/D	Workstations
<b>Intergraph</b> Circle No. 310	Apex	\$10,000	Mixed A/D	Workstations
	AdvanSIM-1076	\$10,500	Digital	Workstations
<b>Intusoft</b> Circle No. 311	ICAP/4Windows	\$2595	Mixed A/D	Windows, Windows NT, Macintosh
<b>Mentor Graphics</b> Circle No. 312	Endeavor	\$26,900	Mixed-signal simulation for custom ICs	Workstations
	HSPICE	\$20,000	Analog	Workstations
	Continuum	\$65,000	Mixed A/D	Workstations
	Accusim II (Eldo)	\$22,000	Analog	Workstations
	Lsim	\$49,500	Digital	Workstations
<b>Meta-Software</b> Circle No. 313	HSpice	\$3500 to \$90,000	Analog	Workstations, PCs, Cray
<b>MircroSim</b> Circle No. 314	PSpice A/D	\$5450 to \$15,900	Mixed A/D	Workstations and PCs
<b>Tanner Research</b> Circle No. 315	T-Spice Pro	\$1245 to \$3650	Analog	Workstations and PCs
<b>Viewlogic</b> Circle No. 316	Mixed-Signal Designer, HSpice	\$48,500 to \$53,500	Mixed A/D	Workstations and PCs



### Modeling levels supported

Transistor	Behavioral (digital)	Behavioral (analog)	Languages supported by simulator	Notes
Yes	Yes		VHDL, C	Mixed-event and cycle-based simulation with limited analog support.
	Optional		Spice	Simulator lets you trade off simulation accuracy against run time. Interface to AUSSIM optional.
Yes	Yes	Yes	VHDL, C, Verilog HDL-A, Spice	VHDL-based A/D simulation in one simulation environment.
Yes	Yes	Yes	Mast, C, Fortran, Spice	MAST HDL for analog and mixed-signal modeling. Digital simulator interfaces available.
Yes	Yes	Yes	VHDL, Spice, C	
Yes	Optional		Spice	Digital simulator optional.
Yes	Optional	Yes	VHDL, Verilog	Requires the Spectre simulator. Digital simulator optional.
Yes	Optional		Spice	Digital simulator optional.
Yes	Yes	Yes	Spice, MainSail	Uses Anacad EES Eldo analog simulator.
Yes	Yes	Yes	Spice	Simulates mixed-signal, signal integrity, EMI, EMC, VLSI, RF, and microwave designs.
Yes	Yes	Yes	C	
Yes	Optional		C	Verilog interface optional.
Yes	Optional	Yes	C, Verilog	Verilog interface optional.
Yes		Yes	Spice, Diablo	Diablo is a behavioral language based on C.
	Yes		VHDL, C, DSPARC	For simulating more complex system, cosimulate with the analog simulator.
Yes	Yes	Yes	Spice2, Spice3, C, Proprietary Boolean and digital languages.	General purpose and high frequency up through RF and microwave. The system includes over 5000 models.
Yes	Yes	Yes		
Yes			Spice	
Yes	Yes	Yes	VHDL, HDL-A, C, Spice.	Combination of Accusim II and Quicksim II.
Yes		Yes	HDL-A, C, Spice	
Yes	Yes		VHDL, C, Spice	
Yes			Spice	Requires interface software for mixed-signal simulation.
Yes		Yes	Spice	Native mixed-A/D simulator.
Yes			Spice, C	Table-based model evaluations for improved simulation speed.
Yes	Yes	Yes	VHDL, Verilog, C, Spice	Simulation backplane option provides cosimulation with 10 different simulators. Support for LSim, Zycad, Saber, HSpice, and PSpice.

 To get information from all the manufacturers in this table, Circle No. 317



## MIXED ANALOG-DIGITAL SIMULATION

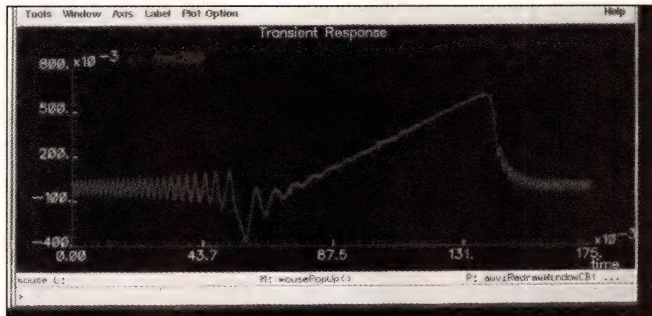
you may want the detail provided by a transistor-level Spice simulation, and you may end up running the simulation for hours to get the final verification. At the early stages of a design, you can often find and correct many errors or simply perform system design tradeoffs while working with simpler behavioral models of the system.

The situation remains somewhat analogous to finding functional design problems in a digital design with a cycle-based simulator. In a synchronous design, the cycle-based simulator ignores timing issues and assumes the functional logic reaches the next logic state within the allotted time. You can hammer out the functional design problems first before attacking the timing issues.

In the analog case, you define the behavior of a circuit with behavioral models before descending into the detailed behavior. In essence, you try to solve the system-level concern of specifying the design of a system that does what you want before designing the implementation details. While the concept is generally sound, you may run into problems.

In the digital case, the cycle-based

simulation initially lets you ignore timing, but eventually you must face timing issues. When you bring in the reality of timing issues, you may find that



**This phase lock loop was modeled using Spectra HDL. The photo shows the PLL output as the input frequency is swept. The output, initially out of lock, goes into lock and then goes out of lock. A multiple-hour simulation at the device level, the simulation takes only seconds at the behavioral level.**

your system design won't work. You need to add pipelining or other major changes to the architecture to satisfy the timing.

In going from a simple analog behavioral simulation to a more refined behavioral simulation or a transistor-level simulation, you may also find that some of the simplifications you made prevent the system from working. The problem could result from input capacitance, temperature drift, or any number of problems that you may have ignored in your behavioral model.

As always, whether you model a circuit in Spice at the transistor level or use behavioral-level models, the engineering judgment you use in creating the models and running the simulation determines whether the simulation accurately models the system. In addition, you want to explore all the potential problems.

In using simulators that accept the VHDL-A or Verilog-A languages, you don't have to give up any Spice models. All the simulators mentioned accept Spice models along with the HDL models. Spectre HDL lets you mix all three types of models in the same system simulation to give you the greatest flexibility.

To take advantage of the simulation speed potential of behavioral models, however, you need to model all or most of your system with them. Although you can translate a Spice model into a behavioral model manually, Cadence offers the Resolve optimizer to help automate the process. The optimizer helps you refine the behavioral model to accurately reflect the results of the Spice model simulation within 1 to 2%. Once you've optimized the behavioral model, you can use it in a system simulation and obtain much faster simulations.

## MANUFACTURERS OF MIXED ANALOG-DIGITAL SIMULATORS

For free information on the mixed analog-digital simulation products discussed in this article, circle the appropriate numbers on the postage-paid Information Retrieval Service card or use EDN's Express Request service. When you contact any of the following manufacturers directly, please let them know you read about their products in EDN.

**Altium/IBM**  
San Jose, CA  
(408) 534-4115  
**Circle No. 301**

**Anacad EES**  
Milpitas, CA  
(408) 954-0600  
**Circle No. 302**

**Analogy**  
Beaverton, OR  
(503) 626-9700  
**Circle No. 303**

**AT&T Design Automation**  
Murray Hill, NJ  
(800) 875-6590  
**Circle No. 304**

**Cadence Design Systems**  
San Jose, CA  
(408) 943-1234  
**Circle No. 305**

**Compass Design Automation**  
San Jose, CA  
(408) 433-4880  
**Circle No. 306**

**Contec Microelectronics USA Inc**  
San Jose, CA  
(408) 434-6767  
**Circle No. 307**

**Dolphin Integration**  
Santa Clara, CA  
(408) 727-7619  
**Circle No. 308**

**Epic Design Technology**  
Santa Clara, CA  
(408) 988-2997  
**Circle No. 309**

**Intergraph Electronics**  
Huntsville, AL  
(800) 837-4237  
**Circle No. 310**

**Intusoft**  
San Pedro, CA  
(310) 833-0710  
**Circle No. 311**

**Mentor Graphics**  
Wilsonville, OR  
(503) 685-8000  
**Circle No. 312**

**Meta-Software**  
Campbell, CA  
(408) 369-5400  
**Circle No. 313**

**MicroSim**  
Irvine, CA  
(714) 770-3022  
**Circle No. 314**

**Tanner Research Inc**  
Pasadena, CA  
(818) 782-3000  
**Circle No. 315**

**Viewlogic Systems Inc**  
Marlboro, MA  
(508) 480-0881  
**Circle No. 316**

### VOTE . . .

Please also use the Information Retrieval Service card to rate this article (circle one):

**High Interest 595**  
**Medium Interest 596**  
**Low Interest 597**

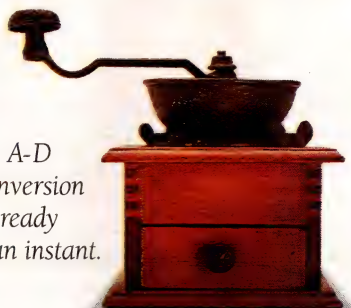
For more information on the products available from all of the vendors listed in this box, Circle No. 317



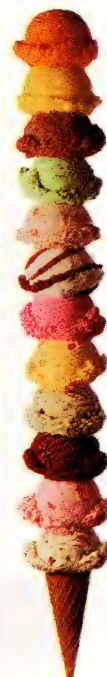


Arm your VME system for industrial control with A-D and servo-motor control modules.

A-D conversion ready in an instant.



Need network connections such as Ethernet, Serial, X.25 or SNA? We'll hook you up with all you need.



Satisfy any taste in VME modules by choosing from over 120 IndustryPack modules on the market.



We offer you a wide spectrum of O/S software choices.

# Think Of This As A VME Smörgasboard.

The Motorola VME product line is like a gourmet buffet. You take what you like, and you'll like what you take.

**Make The Call,  
Not The Board.**

Motorola VME boards offer you more choices. More ways to get the features you need, at a price you can afford. When you select your board from Motorola, you'll save a lot more than time. Add networking options (such as Ethernet, Serial, X.25, SNA), memory, motor control, A-D



conversion, graphics capabilities with either IndustryPack™ or VME modules™.

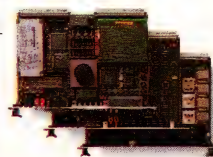
With more than 120 IndustryPack modules and over 3,000 VME modules available industry-wide, your options are unlimited, and your finished product will be dependable.

**Flexible Performance,  
Inflexible Commitment.**

Depend on Motorola VME modules for a variety of design needs. One of our boards can perform multiple

tasks, saving you slots, cash, and hassle. And as your needs change, just add modules to your existing board.

While we serve up a huge menu of VME selections, there's one thing we won't consider changing: our Five-Year Warranty. Call Motorola and you'll get your just desserts.



Motorola VME modules let you select the features you need, at a price you can afford.

For More Information Contact Your Local Motorola Sales Office.

© Copyright 1994 Motorola, Inc. Motorola and the Motorola logo are registered trademarks of Motorola, Inc. "Because The Game Has Changed" and VME module are trademarks of Motorola, Inc. All other products mentioned are trademarks or registered trademarks of their respective holders.

Australia  
61-2-906-3855  
Belgium  
32-2-718-5582  
China (PRC)  
86-1-843-8237

France  
33-1-4674-3560  
Germany  
49-40-236204-0  
Hong Kong  
852-966-3210

Italy  
39-2-8220-239  
Japan  
81-3-3280-8461  
Korea  
82-2-720-0653

Netherlands  
31-30-870857  
Scandinavia  
46-8-734-8800  
Spain  
34-1-329-0461

Taiwan  
886-2-717-7089  
United Kingdom  
44-628-39121



**MOTOROLA**  
**Computer Group**  
*Because The Game Has Changed™*



## MIXED ANALOG-DIGITAL SIMULATION

If you are designing any parts of your system from the bottom-up, you may want to simulate the parts at the transistor level using Spice. Once you've developed that circuit, you can change it into a behavioral model for system simulation.

You can perform behavioral-level modeling at more than one level. When creating the initial design of a system you may opt for behavioral models that encompass large blocks of the system. You may choose to model the system with very idealized behavior. You can easily model idealized comparators, op amps, gain blocks, etc. Once you've blocked out an entire system this way and verified the system at a high level, you can start refining the system, perhaps breaking those large system blocks into smaller blocks. Or, you could just refine the behavior of the large blocks to accurately model the true instead of ideal behavior of the system.

By using this top-down approach to developing and modeling your system, you can save simulation time. The simpler high-level models run quickly. You may be able to use the fast, high-level behavioral models throughout most of a system and use low-level behavioral or transistor-level models for the block you are attempting to verify. This gives you a high-fidelity model of the system block you are verifying and a faster (but still reasonably accurate) model for the rest of the system. You'll need to decide how much detail you need for different blocks to give you an accurate model of the system.

Because transistor-level analog simulation is considerably slower than digital simulation, mixed analog-digital circuits with only 5% of the transistors used for analog circuits will still spend most of the total simulation time evaluating the analog portion of the circuit. Behavioral modeling with analog HDLs helps speed up mixed-signal simulations, even when the analog portion of the design appears insignificant.

Along with analog simulation, many of the simulation tools provide support for nonelectrical disciplines, too. Analog's Saber product pioneered analog

behavioral modeling and multidiscipline simulation. The company still contains the widest library of functions available for mechanical, hydraulic, and other nonelectrical disciplines that you can include in your system simulation. With the wide access to mathematical functions, analog behavioral languages should make it easy for you to model nonelectrical behavior. Modeling nonelectrical systems is not limited to analog behavioral languages, either. Some of the transistor-level Spice simulators can simulate a nonelectrical system. However, the capabil-

simulation of CMOS and BiCMOS circuits, perform accurate simulation of timing and static and dynamic power characteristics. The simulator provides direct simulation of transistor-level mixed-signal circuits. Because the tools are specialized for CMOS and BiCMOS circuits, they can run about 100× faster than Spice while yielding results that fall within 5% of those results produced by Spice. The simulators will accept over 2,000,000 transistors, and they can cosimulate with Verilog.

IBM offers several products aimed at large mixed-signal IC simulation. The company's AUSSIM simulator, primarily a VHDL simulator, contains some limited analog capability. The simulator models and simulates in native compiled code. For complete analog simulation, the company offers SpecSim. This transistor-level simulator is tailored for large digital and memory circuits with a capacity of over 100,000 transistors.

The simulator lets you trade accuracy for speed. The speed-accuracy tradeoff can apply to a complete simulation or on a block-by-block basis, letting you simulate one block of a circuit accurately while using lower accuracy and higher speed for the other circuit blocks. The company claims SpecSim runs 20 to 200× faster than traditional simulators with comparable accuracy. A simulation backplane product called SimMatrix lets you tie the AUSSIM and SpecSim simulators together for mixed-signal systems.

Tanner's T-Spice focuses on ASIC applications. The simulator uses table-based model evaluations to provide faster speed in circuit simulation. The simulator contains the capacity for full chips with over 200,000 elements. **EDN**

### LOOKING AHEAD

Analog extensions to the Verilog and VHDL standards are almost here, and simulation products based on preliminary versions are already out. The HDLs pave the way for analog circuit synthesis, but don't hold your breath. Analog synthesis remains a few years away. For the near future, new products bring faster analog and mixed-signal simulation.

ities and ease with which you can model a nonelectrical system vary.

It's important to remember that, although every mixed-signal designer needs to work with analog design issues, not every analog designer is involved with digital design. Those designers who work mostly in analog and never need a digital HDL may not need the analog extensions of VHDL or Verilog. They may find Spice and possibly proprietary analog behavioral modeling languages meet their needs. The designer most likely to benefit from the new mixed-signal behavioral languages is the designer of large, mixed-signal systems, particularly those systems using mixed-signal ASICs.

Many of the mixed-signal simulation tools shown in **Table 1** offer features to help in simulating large systems. AT&T's ATTSIM is a single simulator for mixed-signal ICs and has the capacity for complete board-level system simulation. The simulator automatically partitions the analog section into multiple blocks and lets you use different time steps with each block to perform long simulation on circuits with multiple time constants.

Epic's Timemill and Powermill simulation tools, intended specifically for

Technical Editor Doug Conner can be reached at (805) 461-9669; fax (805) 461-9640.

### VOTE

Please use the Information Retrieval Service card to rate this article (circle one):

High  
Interest  
595

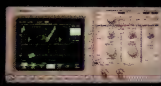
Medium  
Interest  
596

Low  
Interest  
597





**NEW [TDS 310]**  
2 Chan/50 MHz



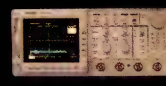
**NEW [TDS 410]**  
2 Chan/150 MHz

#### the TDS 500 series

Precision, extended  
record length and  
waveform analysis



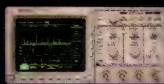
[TDS 544A]  
4 Chan/500 MHz



[TDS 644A]  
4 Chan/500 MHz

#### the TDS 300 series

Our most affordable  
family of DSOs



[TDS 420]  
4 Chan/150 MHz



[TDS 520A]  
2 Chan/500 MHz



[TDS 620A]  
2 Chan/500 MHz

#### the TDS 800 series

Highest resolution  
and bandwidth



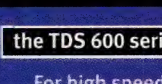
[TDS 320]  
2 Chan/100 MHz



[TDS 460]  
4 Chan/350 MHz

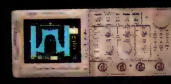


[TDS 524A]  
2 Chan/500 MHz



#### the TDS 600 series

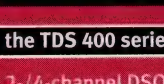
For high speed  
digital/analog  
applications



**NEW [TDS 684A]**  
4 Chan/1 GHz



**NEW [TDS 350]**  
2 Chan/200 MHz



#### the TDS 400 series

2-/4-channel DSOs  
for bench and field  
applications



[TDS 540A]  
4 Chan/500 MHz



[TDS 640A]  
4 Chan/500 MHz



[TDS 820]  
2 Chan/6 GHz

## The Scope of Choice. No Matter Which One You Choose.

It should come as no surprise that Tektronix sells more high performance oscilloscopes than all other companies combined. Because, across the board, the Tektronix TDS family delivers superior performance and usability at every price point. And superior price at every performance point. ■ From the new \$2,300 TDS 310 to our 5 GS/s 1 GHz TDS 684A, every TDS scope has the same highly intuitive graphical user interface. Learn one TDS scope and you've learned to use them all. So it's easy to move from scope to scope. And from project to project ■ Our exclusive NuColor™ technology gives you the

New TDS 684A:  
4 channels of  
1 GHz real-time  
acquisition, pow-  
erful triggering  
and advanced  
probing solutions.

industry's best full-color display, for about the same price as competitive monochrome scopes.

■ Using our new ultra small FET probes you can access today's highest density devices safely and accurately. TDS scopes even streamline documentation by saving screens in popular

desktop publishing formats. ■ Of course the only way to get the full story is to contact your

nearest Tektronix representative today. Or call 800-426-2200, ext 284. Make your next scope the scope of choice.

**Tektronix**



Copyright 1994 Tektronix, Inc. All rights reserved. Tektronix, Tek and NuColor are trademarks.

03W-284512

CIRCLE NO. 106

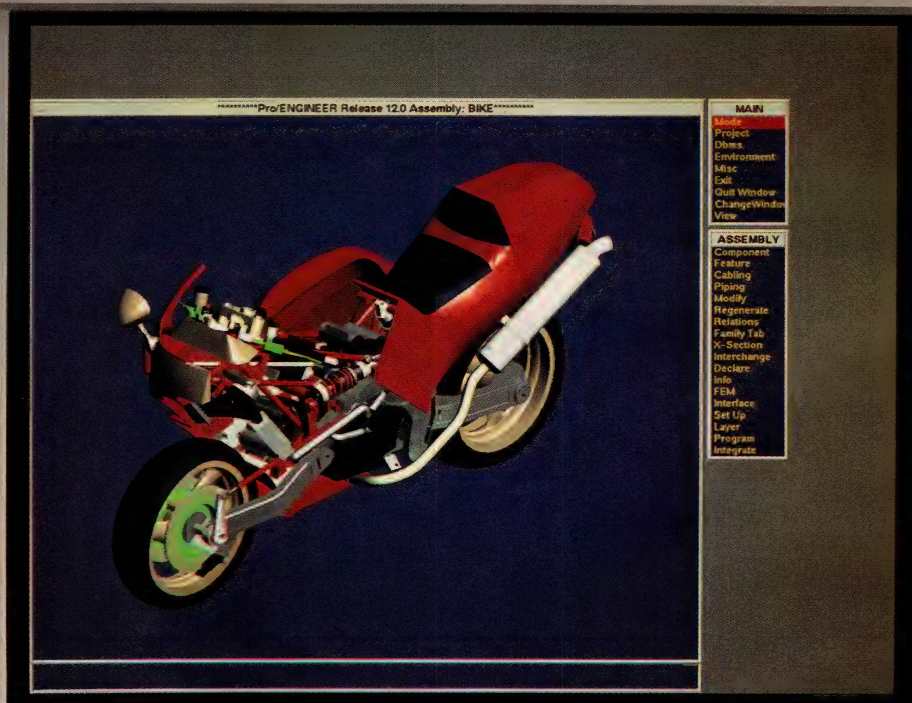


DEC 3000



"With these workstations based on Alpha AXP chip technology, Digital continues to lead in performance and price/performance."

Dominic Ricchetti, Director  
Workstation Research, Dataquest®



P u t t i n g   T e c h n o l o g y

JCW © Digital Equipment Corporation, 1994. The DIGITAL Logo, the AlphaGeneration Logo, Alpha AXP, and DEC 3000 are trademarks of Digital Equipment Corporation. Dataquest is a registered trademark of Dataquest, a company of the Dun & Bradstreet Corporation. Screen image courtesy of Parametric Technology Corporation.



# The Speed Will Blow Your Mind. The Price Won't Blow Your Budget. The Competition Will Blow Its Stack. Again.

## Introducing Two New Additions To The World's Fastest Family Of 64-Bit Workstations.



You don't stay the leader in workstation performance by resting on your CPUs.

You do it by creating a new generation of rockets like the new DEC 3000™ Model 900 deskside and Model 700 desktop workstations. Powered by the Alpha AXP™ microprocessor, they're not just the fastest machines for the money. But the fastest. Period.

Giving you true 64-bit computing for power-hungry applications, sizzling 2D and 3D graphics performance, faster data analysis and shorter design cycles. As well as access to a portfolio of more than 5000 applications, including all the ones you really need. And if that excites the power user in you, check out the easily upgradable Model 600, now the most powerful workstation for under \$20,000. So pick up the phone and find out more. Because our workstations are guaranteed to blow you away.

Again.

### The New DEC 3000 Model 900 Deskside

	DEC Model 900	HP 735/125	IBM 59H	SGI Indigo2XZ
<b>SPECfp92</b>	264	201	251	97
<b>SPECint92</b>	189	136	123	88
<b>ENTRY PRICE</b>	\$43,373	\$39,995	\$74,850	\$28,500

### The New DEC 3000 Model 700 Desktop

	DEC Model 700	HP 735/125	SGI Indigo2XZ	IBM 38T	SUN 20/61
<b>SPECfp92</b>	231	201	97	205	103
<b>SPECint92</b>	163	136	88	114	89
<b>ENTRY PRICE</b>	\$27,698	\$39,995	\$24,500	\$33,300	\$17,995

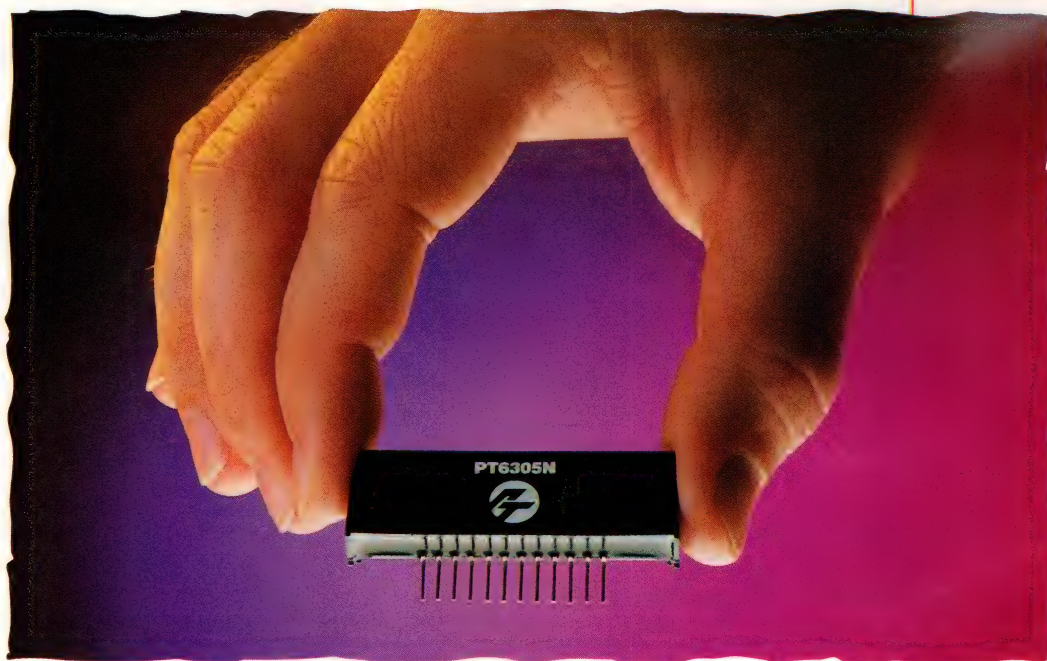
**CALL 1-800 DIGITAL**

**T o W o r k**

**digital**



# SINGLE-DEVICE **5V TO 3.3V** POWER



## ...THAT PLUGS RIGHT IN. ←



Now, from the innovator in integrated switching regulators, comes a new series of high-performance 5V to 3.3V, 3 Amp, 12-Pin, single in-line products.

The new Power Trends PT6305 family lets you easily solve the problem of integrating low power 3.3V logic integrated circuits into existing 5V systems, *without redesigning the power supply.*

And, because the PT6305 Series has an extremely low profile of .36" x 2.00" x .60" (H),

it's ready to meet your needs *and* conserve board space. Vertical, horizontal and surface mount versions are available.

The PT6305 features a high operating frequency of 650KHz, for state-of-the-art power density and 85% efficiency. The device supports a wide input range of 4.5 to 10V with good line and load regulation. Over-temperature and short circuit protection are built in.

If you're ready for a space-saving on-board power converter that you can plug right in, *call Power Trends for a sample today!*  
**1-800-531-5782.**



**POWER TRENDS®**

1101 North Raddant Road, Batavia, IL 60510 • (708) 406-0900 • Fax (708) 406-0901

CIRCLE NO. 94





## SPARKS OF GENIUS.

Small wonders, you could call them. Abbott's SM family of surface mount DC to DC converters are the most reliable very high density power supplies available today. Guaranteed to operate without derating over the full-Mil temperature range from -55° to 100°C. And delivering up to 280 Watts at better than 50 Watts per cubic inch, in an industry standard footprint.

Rugged durability is just the beginning. Inside their tough exteriors is a constant frequency topology that minimizes ripple and makes filtering a breeze. The exclusive use of commercially available, fully derated components eliminates the risk of underperforming on specs —

or stretched out or missed deliveries. Plus full overvoltage and over temperature protection with (n + 1) paralleling for designing in redundancy and backup. Even a companion filter module and an input transient suppressor, to make your designs simpler and more compact.

For all this ingenuity, delivery is quite predictable. Get the whole family off-the-shelf. With 50, 100 or 200 Watt outputs. Single or dual output configuration. For inputs ranging from 28 to 270 VDC.

Talent recognizes genius, they say. In that case, call Abbott to try out the SM family. And prepare to be impressed.

MODEL	SM100S	SMH50	SM100D	SMF200	SM1275
SPEC	SM200S	SMH100	SM200D		
PRODUCT DESCRIPTION	SINGLE OUTPUT	HALF-SIZE SINGLE OUTPUT	DUAL OUTPUT	HALF-SIZED EMI FILTER	HALF-SIZED TRANSIENT SUPPRESSOR
PEAK POWER IN WATTS	100 / 280	50 / 100	100 / 200	375	300
INPUT VOLTAGE (VDC)	16-50 and 200-400				MIL-STD-1275A MIL-STD-704A
OUTPUT VOLTAGE (VDC)	2, 3.3, 5, 5.2, 12, 15, 24, 28	±5, ±12, ±15	—	—	—

**abbott**  
when reliability is imperative®

CIRCLE NO. 48



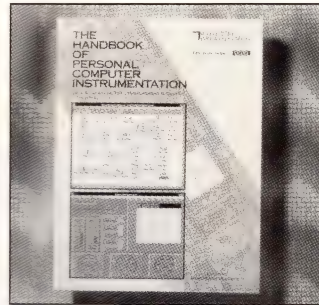
**Data book on DSP products.** This 532-pg data book describes the vendor's high sample-rate hard-wired DSP chips for communications, video, and imaging applications. The book provides long-form data sheets and application notes for multipliers, filters, video-processing chips, signal synthesizers, and down-converters/demodulators. The publication also describes the development software and evaluation boards for the chips. **Harris Semiconductor**, Melbourne, FL. **Circle No. 394**

**Report provides info on maximizing telerobot's performance.** This NASA technical brief (Volume 18, No. 5, Item 84) from the JPL New Technology Report NPO-18745 describes the control-software system of an experimental, seven-degrees-of-freedom telerobot. The software elicits

maximum performance from a minimal, fixed-software computer at a remote site, according to the report. The report also details a method of controlling the mechanical impedance of the end effector of a redundant robotic manipulator based on adaptive-control theory. **Jet Propulsion Laboratory at California Institute of Technology**, Pasadena, CA. **Circle No. 395**

**Handbook defines 1000 electronic acronyms.** *HOTCAKE*, or *Handbook of a Thousand Common Acronyms to Know in Electronics* defines the most common acronyms for communications, IC design, signal processing, computer architecture, video, graphics, networking, and software. The handbook also includes acronyms for standard organizations, industry societies, consortia, and government agencies

and programs. A single copy of *HOTCAKE* is \$9.75. A two-year subscription (four issues) sells for \$29. **Rothschild & Associates**, Sharon, CT. **Circle No. 396**



**Handbook for PC instrumentation.** The seventh edition of the *Handbook of Personal Computer Instrumentation* covers PC-based data-acquisition, test, measurement, and control information. The 228-pg book details the fundamentals of signal conditioning, wiring, shielding, and data acquisi-

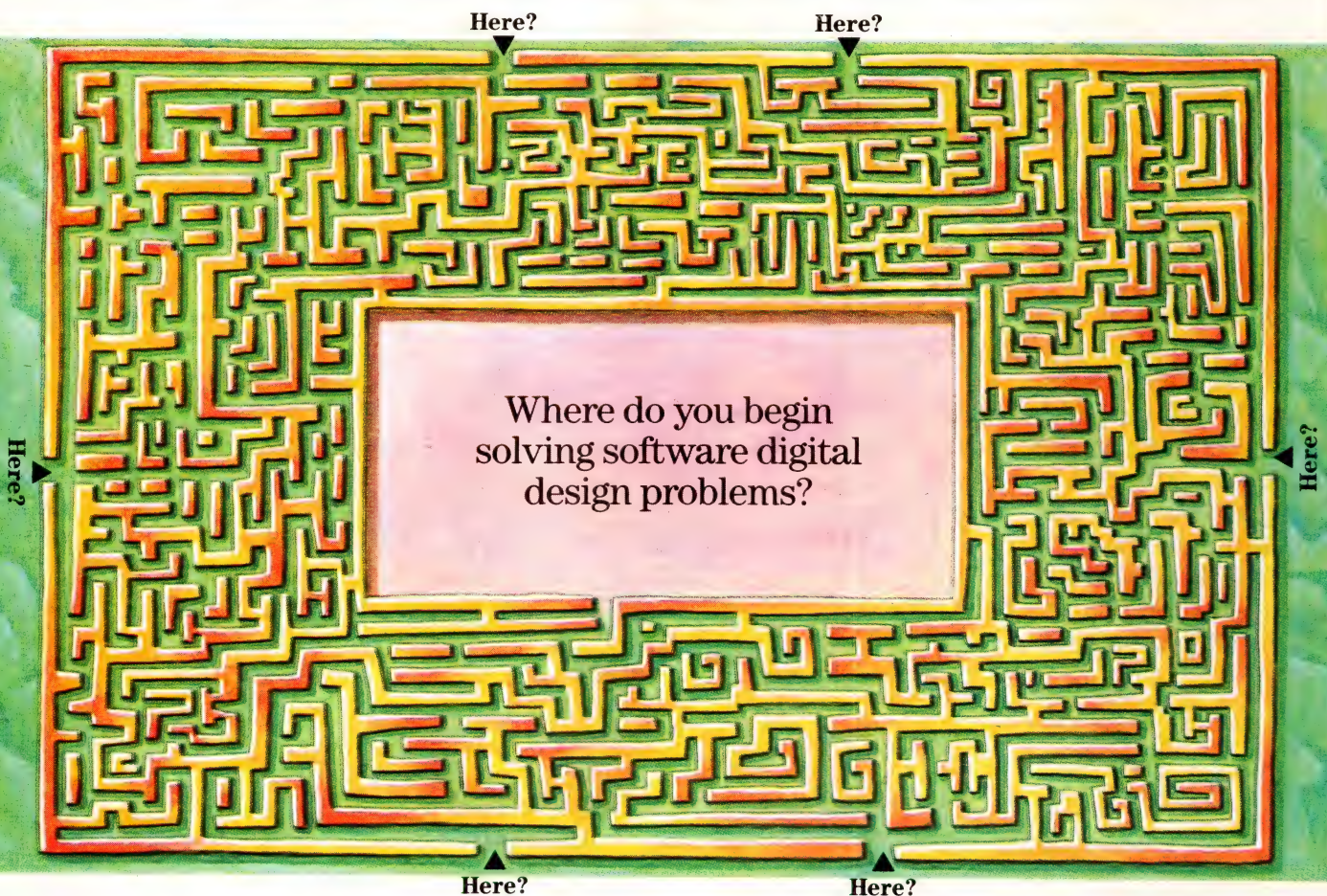
tion and provides techniques and application notes. **Intelligent Instrumentation**, Tucson, AZ.

**Circle No. 397**

**Catalog covers five product lines.** A 64-pg color catalog contains specifications and selection guides for data-conversion components, modular dc/dc converters, digital panel meters, analog boards for the PC/AT and EISA buses, and analog boards for the VMEbus. **Datel Inc**, Mansfield, MA.

**Circle No. 398**

**Data book features STD 32 computers.** This 464-pg book provides features, specifications, and ordering information for the vendor's STD 32 computers. The data book lists support services and offers selection guides. **Ziatech Corp**, San Luis Obispo, CA. **Circle No. 399**





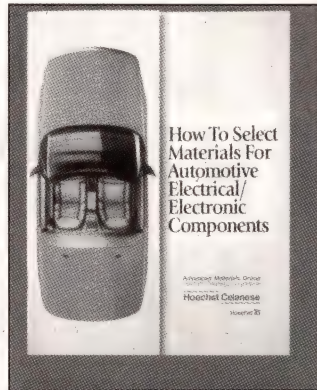
**Catalog features manufacturing and repair products.** This 212-pg catalog describes the vendor's electronic manufacturing and repair products. The publication lists products for static control, soldering, pc-board materials, EMI/RFI shielding, thermal management, sleeving, and insulating. **Electrical Insulation Suppliers, Hillside, IL.**

**Circle No. 400**

**Journal highlights signal-processing circuits, systems, and software.** *Analog Dialogue* (Volume 28-1) discusses the vendor's TMP01 single-chip, temperature sensor/setpoint controller, the 1B60 intelligent digitizing signal conditioner, and the AD2S100 analog vector processor for motor control. The free publication also includes application articles on using IC-voltage references and sigma-delta-

architecture A/D converters. **Analog Devices, Norwood, MA.**

**Circle No. 401**



**Selection guide for choosing plastics for automotive electrical and electronic components.** *How to Select Material for Automotive Electrical/Electronic Components* describes seven engineering and high-performance thermoplastics for use in automotive electrical and electronic compo-

nents. The guide features solutions to the demand that today's auto environment places on E/E systems and components. The brochure also describes the use of resins to solve engineering problems in the design and manufacturing of ignition and power-distribution systems, sensors, switches, and actuators. **Hoechst Celanese, Chatham, NJ.**

**Circle No. 402**

**Selection guide covers force-balance servo accelerometers and inclinometers.** This 24-pg catalog features the operating modes, engineering data, and model variations for force-balance sensors and inclinometers. The brochure details low-cost, general-purpose, high-performance, tri-axial, and high-temperature sensors. **Columbia Research Laboratories Inc., Woodlyn, PA.**

**Circle No. 403**

**Brochure describes self-locking fasteners.** This free brochure details self-locking fasteners, explains how they work, and details applications and design solutions. The handbook provides design information for engineers who work with threaded fasteners. **Long-Lok Fasteners Corp., Cincinnati, OH.**

**Circle No. 404**

**Newsletter aims at OEM power and magnetic specifiers.** *Current Events* discusses pertinent design, regulatory, application, and manufacturing concerns of OEM power and magnetic specifiers of 50/60-Hz transformers from 1 VA to 10 kVA. **Signal Transformer Co., Inwood, NY.**

**Circle No. 405**

**Brochure outlines components.** This brochure describes the vendor's high-performance EMI/RFI-sup-

Did you ever think being an engineer could be so frustrating? You've worked hard to acquire the experience and expertise you need to push the technological envelope. Yet, instead of solving your most challenging problems, you can spend most of your day bumping into dead ends.

That's not the best use of your time, or your mind. Which is why HP is offering a smarter way for you and your team to work. Our philosophy is simple: give you all the information you need, in a relevant and useable format, so you can find problems through logical thinking, not guesswork.

### How HP's design philosophy gives you faster insight.

First, you need to have the right tools available. We've developed a complete range of affordable software tools – from ROM monitors to Background Debug Mode and high performance emulators – so no matter what problem you're troubleshooting, applying the right solution is easy.

To spend  
less time guessing  
start here.

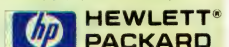
Second, you need to have information that's not only in a language you understand, but in a context that's relevant. That's why real-time, high-level language debugging is our standard. Because if you can see how your code relates to the system – right when an error occurred – you'll immediately know what caused the problem.

Finally, you need tools that will get used. We designed easy-to-use, open systems with verified connections to leading software vendors. So you'll feel confident choosing the best tools, knowing that if they work well together, so can you and your project team.

### Get started today.

For faster insight into your software design problems, call one of the numbers listed below and ask for our free "Your Solution's In Sight" Kit. It includes a product demonstration disk, a Software Designer Concept brochure, and technical literature on HP's entire family of software solutions.

Or just turn the page.



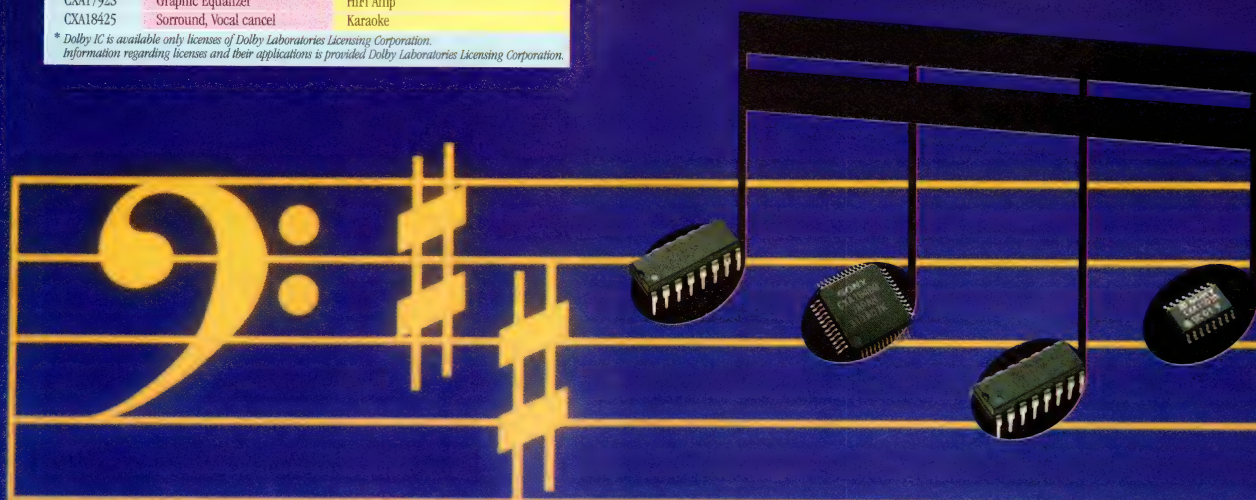


# SONY. THE WORLD'S LEADING PLAYER IN HIGHER PERFORMING ANALOG AUDIO ICs.

ANALOG AUDIO IC AND APPLICATION		
PRODUCT	FUNCTION	APPLICATION
CXA1549S	Recording/PB Equalizer	Double Cassette Tape Recorder
CXA1579M	Recording Equalizer	Cassette Tape Recorder/Radio Cassette
* CXA1102M	Dolby B	Cassette Tape Recorder
* CXA1332	Dolby B/C	Cassette Tape Recorder
* CXA1417S	Dolby S	Cassette Tape Recorder
* CXA1580Q	Dolby B + PB Amp + AMS	Car Audio
* CXA1897Q	Dolby + REC/PB Equalizer	Radio and Cassette Tape Deck
CXA1599Q	PB/Req Equalizer, HP Amp	Double Cassette Deck
CXA1635M	Pre-Power AMP	Headphone Stereo
CXA1846Q	Electrical Volume	HiFi Amp, Cassette Deck
CXA1792S	Graphic Equalizer	HiFi Amp
CXA1842S	Surround, Vocal cancel	Karaoke

\* Dolby IC is available only licensees of Dolby Laboratories Licensing Corporation. Information regarding licenses and their applications is provided Dolby Laboratories Licensing Corporation.

ANALOG AUDIO IC AND APPLICATION		
PRODUCT	FUNCTION	APPLICATION
CXA1568M	Audio SW	Amplifier
CXA1644P	Echo Effect	Karaoke, Surround
CXA1649M	Bass boost	Headphone Stereo
CXA1600M	AM Radio	Pocket Radio, Clock Radio
CXA1611M	AM/FM Radio	Headphone Stereo, Radio Cassette



Sony is giving a new lease of life to analog audio with its range of advanced processors. Many of the world's leading audio producers already use the Sony CXA series to control critical analog applications like *Dolby B/C/S*, *PB Equalizers*, *Graphic Equalizers*, *Electrical Volume*, *AM & FM Radio*, and *Surround Sound*.

The highly efficient Sony designs enable audio designers to improve performance while cutting the numbers of external parts needed. And that also helps to increase reliability and reduce production costs.

In fact, as world leaders in the design, development and manufacture of semiconductors, Sony is a big player in every sense. In high volume production. In just-in-time delivery. In technical support.

For more information on the way Sony semiconductors can improve your products' performance, please phone or write to:

Sony International Offices:

United Kingdom: SSE, UK Sales. Tel: +44 932 816175.

Germany, Switzerland & Austria: Sony Europa GmbH, CPCE. Tel: +49 89 82916 442.

France & Spain: Sony France SA, Semiconductor Department. Tel: +33 1 40 87 33 86.

Scandinavia, Italy & Other Areas: Tel: +44 256 478771 (Ext. 407).

Alternatively, write to Donna Crowley at:

**Headquarters: Sony Semiconductor Europe, Priestley Road, Basingstoke, Hants RG24 9JP. Tel: +44 256 478771 (Ext. 432). Fax: +44 256 818194.**

## SONY®



pression devices, relays, and transformers. Eichhoff Electronics Inc, Warwick, RI.

**Circle No. 406**

**Catalog features semi-rigid products.** This 68-pg catalog details a line of semi-rigid cables, resonators, and delay lines. The catalog also describes MIL-SPEC, very-low-loss, low-impedance, high-temperature, and triaxial cables. Micro-Coax, Collegeville, PA.

**Circle No. 407**

**Semiconductor product guide.** This selector guide features power semiconductors, including transistor, rectifier, and thyristor modules and discrete high- and low-power products. Selector tables provide parametric data, number systems, and package outlines for each product. Powerex Inc, Youngwood, PA.

**Circle No. 408**

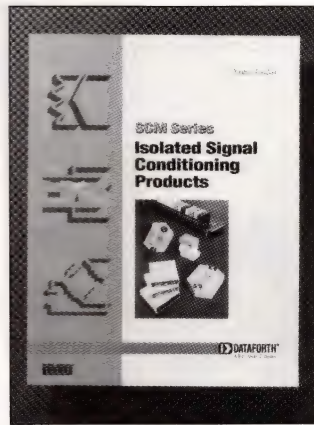
**Brochure details bearing selection and graphics package.** This four-pg brochure highlights the vendor's details bearing dimensions, load ratings, calculation factors, speed ratings, and abutment dimensions. The publication also covers a graphics program that lets users access a library of bearing drawings. Users can import these drawings directly into a CAD program or other documents. SKF USA Inc, King of Prussia, PA.

**Circle No. 409**

**Catalog features IEEE-488 and notebook-PC-based data-acquisition products.** This free 152-pg catalog describes hardware and software products for IEEE-488 control and notebook-PC-based data acquisition. The coverage of IEEE-488 products includes instrument controllers, bus analyzers, bus extenders, ser-

ial-to-IEEE-488 converters, and IEEE-488 data-acquisition instruments. IOTech Inc, Cleveland, OH.

**Circle No. 410**



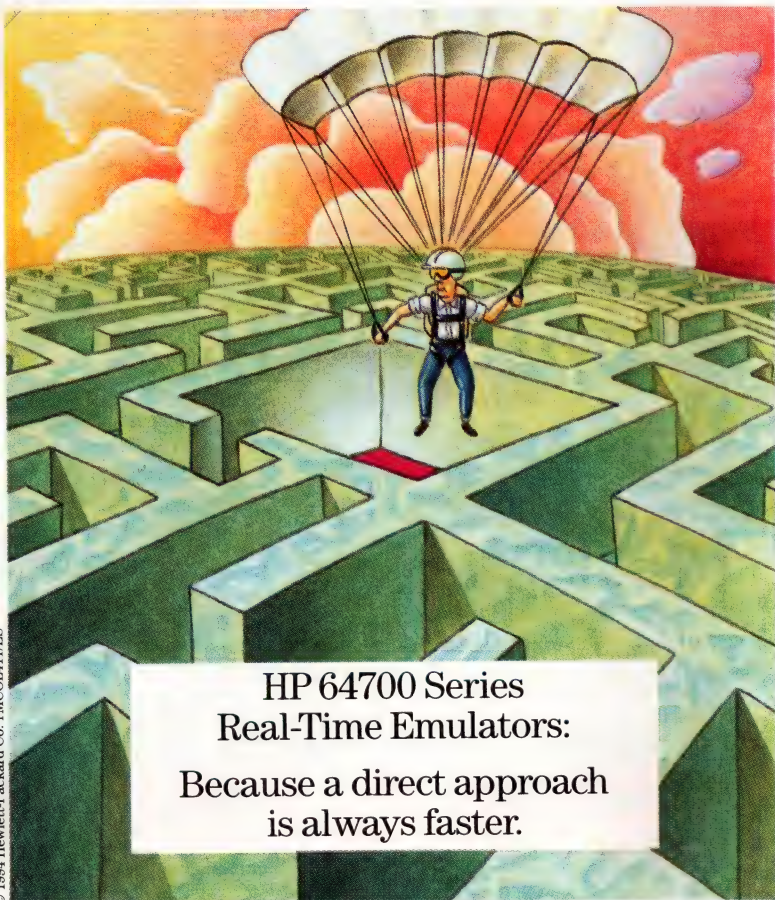
**Catalog features analog and digital I/O modules and accessories.** This 100-pg catalog contains descriptions, specifications, and application notes for a line of analog and digital I/O mod-

ules and accessories. The publication contains detailed technical guides for Dataforth's three SCM product families: SCMSB isolated analog I/O products, SCM9B isolated intelligent I/O products, and SCMD digital I/O products. Dataforth Corp, Tucson, AZ.

**Circle No. 411**

**Power-supply reference book.** *Considerations When Specifying Switchmode Power Supplies* covers a variety of topics, including reliability, agency approvals, EMC, power-factor correction, specification writing, strife testing, custom vs standard, vendor selection, thermal management, and power density. The 32-pg guide also contains appendices for major safety and quality agencies, mechanical and electrical considerations, and a bibliography. MicroEnergy Inc, Longwood, FL.

**Circle No. 412**



**HP 64700 Series  
Real-Time Emulators:  
Because a direct approach  
is always faster.**

Looking at information one piece at a time can send you down a lot of blind alleys. That got us thinking. What if an emulator could help you go straight to the answer?

With dual-ported emulation memory and a choice of foreground or background monitors, you could make measurements in real-time – without interrupting your design process.

If you could do high-level C/C++ dynamic debug and analysis, you'd spend less time deciphering code.

Common debugger interfaces would make sharing data with your team easier. And if you could get all this on an emulator for virtually any processor you have, your problems would be solved.

If that sounds like a faster approach to you, call one of the numbers listed below for more information. Or ask for an HP engineer.

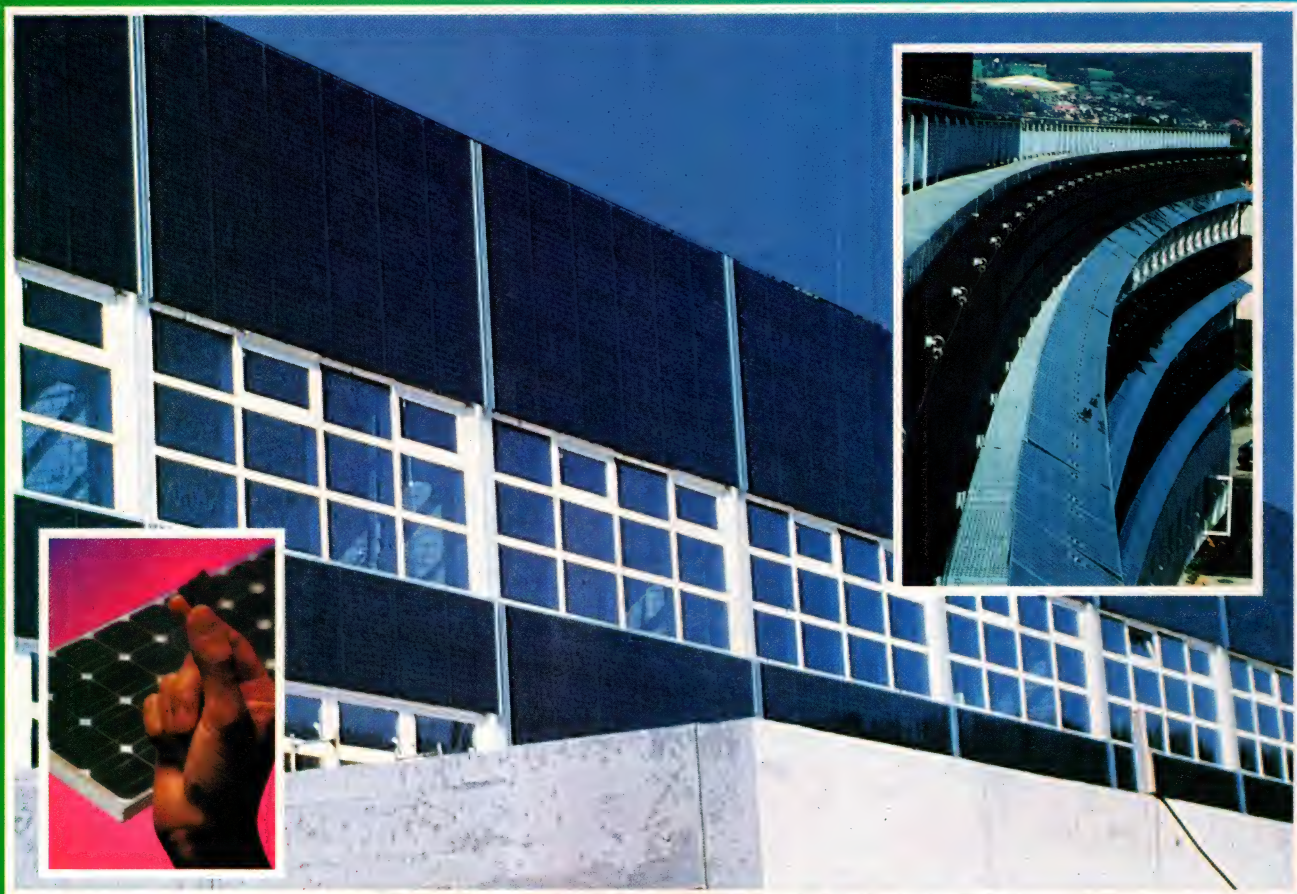
And speak to us directly.

**There is a better way.**





# Solar Power with excellent efficiency



Fotos: Fa. Sulliton AG, CH-Horlingen

As a result of over 30 years experience in monocrystal solar cell technology SHARP can offer highest cell efficiencies available on a production level. Assured quality levels and the cell aesthetic appearance open new applications in building integrated Photovoltaics.

We also manufacture a range of modules from 2.5 to 85 Wp for multiple other applications.

In synergy with other system components, e.g High-Brightness LEDs, we have realised efficient systems for traffic applications.

SHARP's ongoing program of research and development ensures our commitment to Photovoltaics Technology.

CIRCLE NO. 36

SHARP ELECTRONICS (EUROPE) GMBH  
Microelectronic Division (MED)  
Sonninstraße 3, 20097 Hamburg  
Phone +49-40/2376-2286, Telex 2 161 867  
Telefax +49-40/2376 22 32

SHARP ELECTRONICS (EUROPE) GMBH  
Liaison Offices in  
Paris · Milano · Stuttgart · Nürnberg · London · Dublin

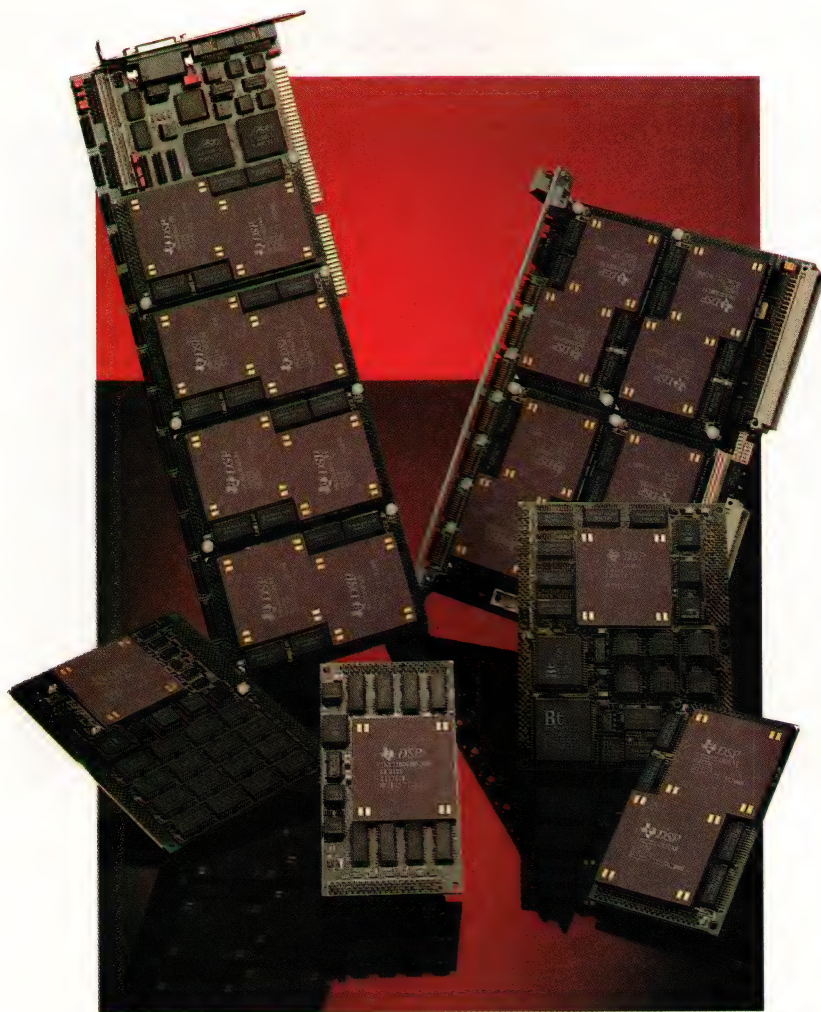
# SHARP

THE IDEAS COMPANY



# Build the Perfect DSP System

NOW  
AVAILABLE  
**50** MHz



## Use the Ultimate in Modular DSP

Call us now  
to find out just how easy it is

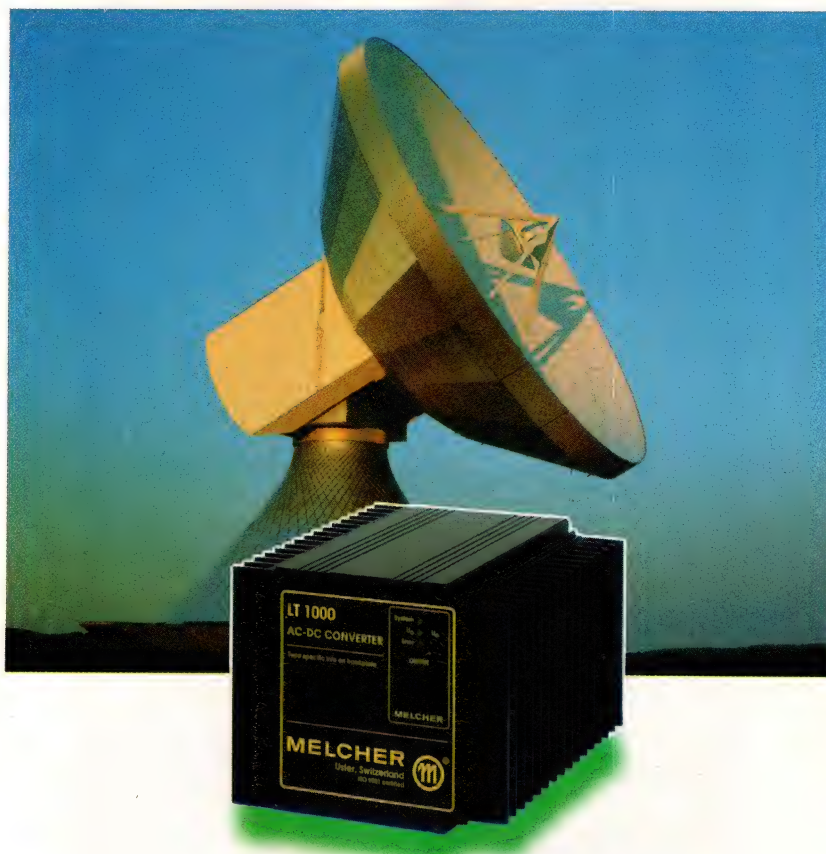


**Loughborough  
Sound Images Limited**

THE TECHNOLOGY CENTRE, EPINAL WAY, LOUGHBOROUGH, LEICESTERSHIRE, LE11 0QE ENGLAND  
TEL: +44 (0)509 231843 FAX: +44 (0)509 262433



# Melcher Power Supplies: For Reliable Telecommunications



Telecoms is characterised as a rapidly changing, high technology industry depending entirely on the reliable operation of its system to generate revenue. The power supply plays a decisive part since it links the systems with the environment. It must be reliable, efficient and comply with all relevant standards. No power supply - no system - no revenue! The cost to the telecoms service provider is a function of the speed to market for the system, and the long term reliability. Melcher offers complete

"off-the-shelf" power supply solutions, capable of meeting high performance standards, and approved to the latest international standards for safety and EMC. Melcher power supplies have a reputation for high reliability and compliance to specification, confirmed by many of the world's leaders in industry. They reduce design-in time, engineering risk and provide long term cost savings which may far exceed any difference in price. Is it not time your company switched to Melcher and reaped the cost benefits?

Supplying great Performance

**MELCHER**

ISO 9001 certified



**CH:** MELCHER AG, Tel. (01) 944 81 11, Fax (01) 940 98 58  
**D:** MELCHER GmbH, Tel. (040) 89 68 27, Fax (040) 89 83 59  
**I:** MELCHER S.r.l. Tel. (02) 66 10 10 63, Fax (02) 66 10 10 62

**F:** MELCHER SA, Tél. (1) 69 05 99 11, Fax (1) 69 96 04 54  
**NL:** MELCHER BV, Tel. (040) 86 86 06, Fax (040) 86 83 99  
**B:** MELCHER BV, Tél. (011) 23 12 46, Fax (011) 23 12 24

**GB:** MELCHER Ltd. Tel. (0800) 31 72 17, Fax (0425) 47 47 68  
**USA:** MELCHER Inc. Tel. (800) 828 97 12, Fax (508) 256 46 42  
**CAN:** MELCHER Corp. Tel. (800) 828 97 12, Fax (508) 256 46 42



# EASY-TO-USE FLASH-MEMORY MODULES EMULATE DISK DRIVES

GARY LEGG, EXECUTIVE EDITOR

**Because more and more flash-memory modules look just like familiar disk drives to your system, designing in fast and rugged mass storage has never been simpler.**

Companies promoting the use of flash memory in mass-storage applications seem to have made an interesting discovery: To convince customers to use flash instead of a disk drive, make the flash *look* like a disk drive. Increasingly, new flash storage products incorporate a hardware controller that emulates a disk drive's system interface.

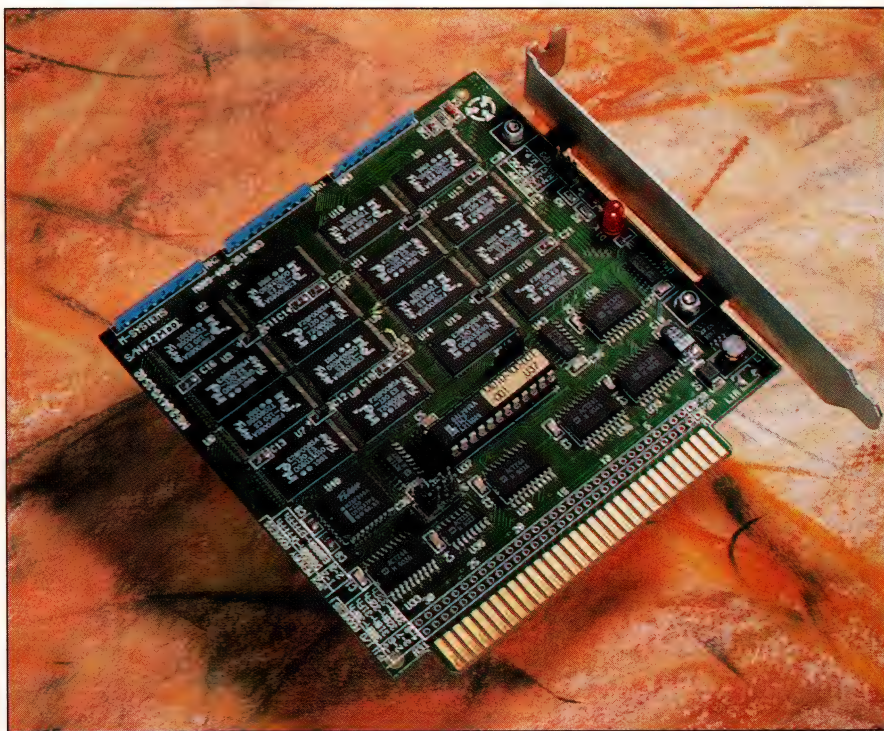
No longer the domain of niche companies, disk-emulation flash storage is now in the mainstream. IBM, Intel, and several disk-drive manufacturers all have products in the form of PCMCIA-ATA (AT Attachment) cards, which include a standard IDE disk interface. Big PCMCIA vendors—Epson, for example—are adding ATA cards to their lines. Only a year or so ago, disk-emulation flash was the realm only of SunDisk and one or two competitors.

## **If it looks like a disk...**

With a familiar disk interface, flash products are easy to design into a system and easy to use. They have little impact on system software, and they allow application programs to work without modification. The main drawback is the added cost of the interface—around \$20 to \$30 for a PCMCIA card.

Falling prices for flash-memory ICs offset the added cost of disk emulation. Intel's 5-Mbyte PCMCIA-ATA card now

sells for \$270 (1000), down from \$310 earlier this year. SunDisk's recent 10 to 30% price cuts will probably result in retail prices of \$179 to \$199 for an ATA card that stores 1.8 Mbytes (3.6 Mbytes with data-compression software). That's as cheap as a disk drive, although disk drives have much higher capacity.



**The PC Flash Disk from M-Systems plugs into any ISA or EISA bus and provides as much as 32 Mbytes of storage. Embedded flash-file-system software makes the board's flash memory appear to the system as a disk drive. An onboard expansion BIOS eliminates the need for any software installation.**



## FLASH DISK

However, if you need only about 5 Mbytes or less, then flash is a better buy.

The variety of new disk-emulation products (**Table 1**) is impressive. In addition to PCMCIA cards, flash "disks" are available as PC plug-in boards, rugged cartridges, and even single ICs. Even physical replacements for 3.5- and 2.5-in. hard drives are available, although their high capacities make them expensive. For example, you can figure on a price of \$5000 to \$6000 for 100 Mbytes.

The proliferation of hardware-based disk emulation indicates a shift away from an alternative approach. The other approach implements disk emulation (or at least flash-memory file handling) in system-resident flash-file-system (FFS) software. Microsoft's (Redmond, WA) FFS and M-Systems' TrueFFS are the best known flash-file systems; others are available from SCM Microsystem (Martinsried, Germany and Santa Clara, CA) and Datalight (Arlington, WA).

The main purpose of FFS software is to work around flash memory's limitations as a mass-storage medium. For example, the software must accommodate flash's erase-before-write requirement, long erase times, lack of byte-by-byte erasability, and limited endurance. (Flash cells can accommodate only a certain number of erase/write cycles and still work reliably.) Hardware-based disk emulation performs the same tasks; it simply moves flash control from the system to the storage devices themselves (**Fig 1**).

### Jumping on the bandwagon

Significantly, some of the latest disk-emulation products come from companies that champion FFS software. Intel, for example, is a longtime backer of Microsoft's FFS. M-Systems recently introduced hardware-based disk-emulation flash products in a variety of forms. Eurom, an M-Systems subsidiary, is marketing a single-chip flash disk that replaces a system's BIOS ROM.

System-resident FFS software is still a viable alternative to disk emulation, however, and may even be the long-term preferred approach. Being software, it's potentially cheaper, and it usually provides somewhat faster read-



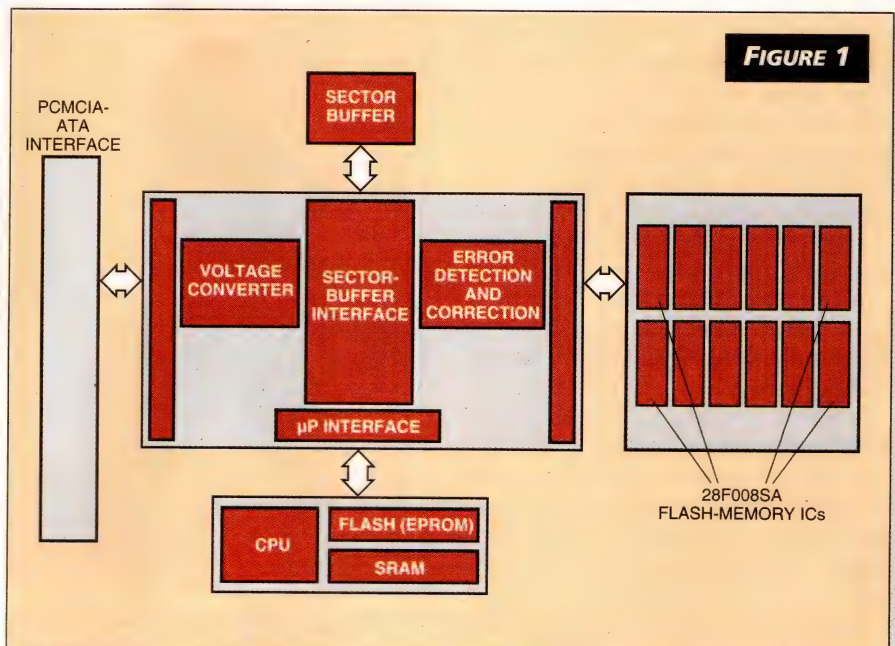
**Disk-emulating PCMCIA-ATA flash cards, such as this one from SunDisk, have capacities as high as 40 Mbytes. Data compression can effectively double the capacity.**

ing and writing. Eventually, its backers say, FFS software will simply be an invisible, but effective, part of most operating systems.

For now, though, flash software's

lack of a large installed base gives impetus to storage products that provide their own flash control. Only new sub-notebook computers are likely to incor-

(Continued on pg 56)



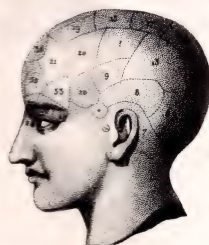
**In addition to flash memory, a PCMCIA-ATA card, like this one from Intel, includes a controller, firmware, and interface logic to make the device emulate a disk drive.**





Our VMEmodules can run even your most demanding applications, such as manufacturing control.

Compute raw integers at faster rates.

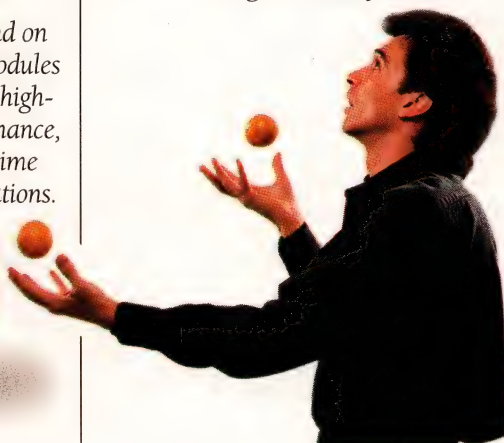


Depend on VMEmodules to run high-performance, real-time applications.



URGENT

One VMEmodule can multi-task many programs single-handedly.



# All In A Billionth Of A Day's Work.

Got a second? Then take a moment to consider the family of VMEmodules from Motorola. With a combination of incredible processing power and advanced peripheral controller technology, these boards are built for speed. And the long haul.

## No Waiting, No Risk.

When you need real-time capabilities in no time, give us a call. Our VMEmodules will satisfy your immediate needs for real-time control and real-



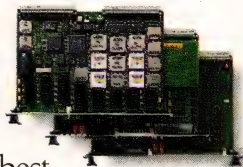
time monitoring. And here's a reality check for you. When you order from Motorola, you'll get the right board, right away, at the right price.

## We Make Every Penny Perform.

Why take chances on your business? Chances are, if you try to bargain for VMEmodules, or build your own, they'll cost you more in the long run. Because they can mean downtime, missed deadlines, and missed opportunities. Instead,

call the world's leading VME maker. We invest quality into our VMEmodules, and we back every one with the industry's first Five-Year Warranty.

The next time you need a fast, reliable VMEmodule™, call Motorola. We'll give you a billion reasons to choose the best.



High-performance Motorola VMEmodules offer incredible processing power for your most demanding applications.

For More Information Contact Your Local Motorola Sales Office.

© Copyright 1994 Motorola, Inc. Motorola and the Motorola logo are registered trademarks of Motorola, Inc. "Because The Game Has Changed" and VMEmodule are trademarks of Motorola, Inc. All other products mentioned are trademarks or registered trademarks of their respective holders.

Australia  
61-2-906-3855  
Belgium  
32-2-718-5582  
China (PRC)  
86-1-843-8237

France  
33-1-4674-3560  
Germany  
49-40-236204-0  
Hong Kong  
852-966-3210

Italy  
39-2-8220-239  
Japan  
81-3-3280-8461  
Korea  
82-2-720-0653

Netherlands  
31-30-870857  
Scandinavia  
46-8-734-8800  
Spain  
34-1-329-0461

Taiwan  
886-2-717-7089  
United Kingdom  
44-628-39121



**MOTOROLA**

**Computer Group**

*Because The Game Has Changed™*



**TABLE 1—REPRESENTATIVE FLASH-MEMORY STORAGE DEVICES**

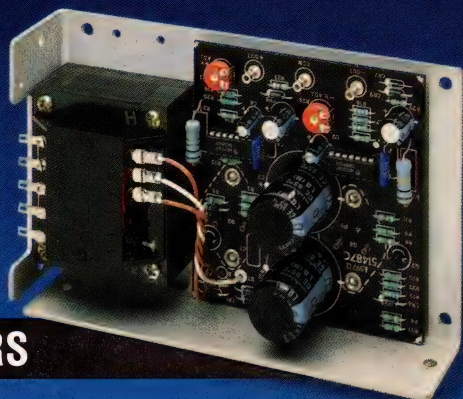
Manufacturer	Form factor	Interface	Disk emulation	Capacity (Mbytes)	Price
<b>Advanced Micro Devices</b> Sunnyvale, CA (800) 222-9323 <b>Circle No. 366</b>	PCMCIA card	PCMCIA	No	1 to 10	\$75 to \$385 (1000)
<b>American Microsystems Inc</b> Pocatello, ID, (208) 234-6661 <b>Circle No. 367</b>	PCMCIA card	PCMCIA	No	0.25 to 4	NA
<b>Cardwell International Corp</b> Folsom, CA (916) 985-1880 <b>Circle No. 368</b>	PCMCIA card	PCMCIA	No	0.5 to 16	\$139 to \$309
<b>Curtis Inc</b> St Paul, MN (612) 631-9512 <b>Circle No. 369</b>	PC plug-in board	ISA bus	Yes	1 to 40	NA
<b>Dovatron</b> Longmont, CO (800) 848-1198 <b>Circle No. 370</b>	Miniature board	ESP	Yes	1 to 16	\$275 to \$1314 (100)
<b>Epson America Inc</b> Torrance, CA (800) 289-3776 <b>Circle No. 371</b>	PCMCIA card	PCMCIA-ATA	Yes	2.5 to 20	\$399 to \$1499
<b>Eurom Inc</b> Tel Aviv, Israel 972-3-490920 <b>Circle No. 372</b> or Santa Clara, CA (408) 748-9995 <b>Circle No. 373</b>	Multichip module	BIOS ROM socket	Yes	1 to 16	\$119 to \$209 (100)
<b>Fujitsu Microelectronics Inc</b> San Jose, CA (408) 922-9000 <b>Circle No. 374</b>	PCMCIA card	PCMCIA	No	0.25 to 16	NA
<b>Hitachi America Ltd</b> Brisbane, CA (800) 285-1601, ext 16 <b>Circle No. 375</b>	PCMCIA card	PCMCIA	No	2 to 10	From \$230 (500)
<b>IBM Microelectronics</b> Hopewell Junction, NY (800) 426-0181 <b>Circle No. 376</b>	PCMCIA card PCMCIA card	PCMCIA PCMCIA-ATA	No Yes	4 to 16 3 to 40	\$216 to \$709 (1000) NA
<b>Intel Corp</b> Santa Clara, CA (800) 879-4683 <b>Circle No. 377</b>	PCMCIA card PCMCIA card	PCMCIA PCMCIA-ATA	No Yes	2 to 40 5 to 10	\$91 to \$1543 (1000) \$270 to \$408 (1000)
<b>Maxtor Corp</b> San Jose, CA (408) 432-1700 <b>Circle No. 378</b>	PCMCIA card	PCMCIA	Yes	2 to 20	NA
<b>Memtech</b> Sunnyvale, CA (800) 445-5511 <b>Circle No. 379</b>	PC plug-in board 3.5-in. drive	ISA/EISA bus SCSI-2	Yes Yes	2 to 32 24 to 432	\$2584 (32 Mbytes, 100) \$50 to \$60/Mbyte
<b>M-Systems</b> Fremont, CA (510) 505-9081 <b>Circle No. 380</b>	PC plug-in board Small board 5.25-in. drive Cartridge Rugged module	ISA bus PC/104 SCSI-2 ISA bus Serial	Yes Yes Yes Yes Yes	1 to 32 2 to 4 2 to 320 1 to 48 2 to 48	From \$139 (100) From \$118 (100) NA NA NA
<b>Quantum Corp</b> Milpitas, CA (408) 894-5088 <b>Circle No. 381</b>	PCMCIA card	PCMCIA	Yes	1 to 10	\$90 to \$520
<b>RadiSys Corp</b> Beaverton, OR (800) 950-0044 <b>Circle No. 382</b>	Small board (embedded)	EXMbus	Yes	10 to 40	\$1744 to \$4470
<b>Raymond Engineering</b> Middletown, CT (203) 632-4334 <b>Circle No. 383</b>	PCMCIA card	PCMCIA-ATA	Yes	1.8 to 40	NA
<b>Seagate Technology</b> Scotts Valley, CA (408) 438-6550 <b>Circle No. 384</b>	PCMCIA card	PCMCIA-ATA	Yes	1 to 40	NA
<b>Silicon Storage Technology</b> Sunnyvale, CA, (408) 735-9110 <b>Circle No. 385</b>	PCMCIA card	PCMCIA	Yes	1 to 14	NA
<b>Smart Modular Technologies</b> Fremont, CA (510) 623-1231 <b>Circle No. 386</b>	PCMCIA card	PCMCIA	No	2 to 4	\$180 to \$230
<b>SunDisk Corp</b> Santa Clara, CA (408) 562-0500 <b>Circle No. 387</b>	PCMCIA card	PCMCIA-ATA	Yes	1 to 40	\$100 to \$2000
<b>Targa Electronic Systems Inc</b> San Ramon, CA (510) 277-0188 <b>Circle No. 388</b>	Cartridge 3.5-in. drive	IDE, SCSI, or serial IDE, SCSI, or SCSI-2	Yes Yes	5 to 40 80 to 500	From \$995 NA

To get information from all the manufacturers in this table, Circle No. 389



# Power-One

## One power supplier for all reasons.



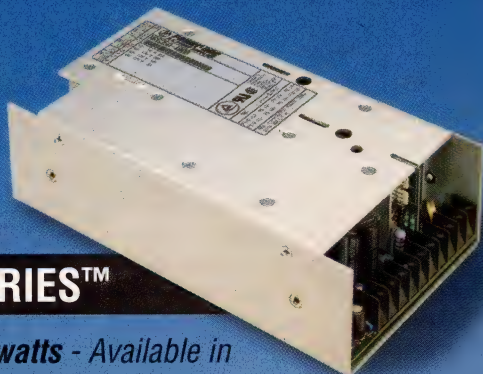
### LINEARS

*Produced in an ISO 9000 certified facility and agency certified to EN60950, Power-One linears continue to set the standards for performance.*



### MAP SERIES™

*40 to 130 watts - This robust low-power switcher product line features autoranging, high power densities and superior regulation.*



### NRG SERIES™

*250 to 550 watts - Available in modular configurations with up to seven outputs or four-output non-modular OEM configurations.*



### HIGH POWER

*500 to 2500 watts - These modular products provide up to 21 outputs. Options include power factor correction.*



# Power-One™

## POWER SUPPLIES

*"Dedicated Supplier For Over 20 Years"*

740 Calle Plano • Camarillo, CA 93012 • [800] 693-0212 • FAX [805] 388-0476



*Call For Our Catalog Today!*



Power-One logo, NRG Series, MAP Series and ISO 9000 logo are trademarks of Power-One, Inc.

CIRCLE NO. 95



## FLASH DISK

porate FFS, and that software comprises incompatible products from various vendors. Few desktop computers have any flash software at all.

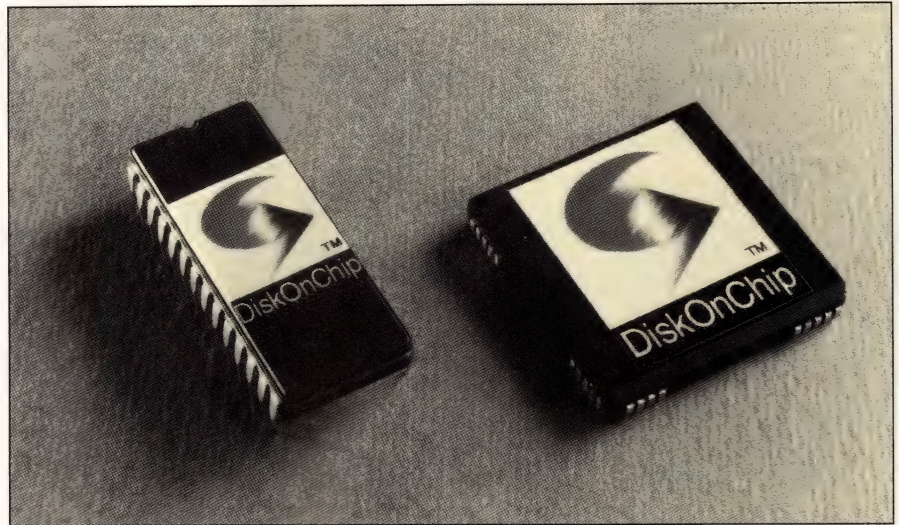
Even so, plenty of flash products still forgo disk emulation. Intel and IBM, for example, sell flash cards with and without disk emulation. Many other companies—for now, at least—are staying with memory-only cards. Fujitsu, for example, has an ATA prototype card, but is looking at market conditions before deciding whether to market it.

Emulating a disk drive isn't necessary or even desirable in all applications, and the additional cost of emulation is often prohibitive. Adding \$20 or \$30 is one thing in a 10-Mbyte device that sells for several hundred dollars; in a cheaper card with much lower capacity, it's something else. And most applications that use flash still require fairly low storage. According to Dave Roeckel, marketing manager of Dovatron, most flash-based embedded-systems applications use 1 to 4 Mbytes.

For the most part, disk-emulation flash and conventional flash serve separate markets. George Robillard, Fujitsu's director of memory products, notes that his company's conventional flash cards find use in industrial and embedded applications, primarily storing program code that needs only occasional updating. Disk-emulation cards, Robillard says, are useful primarily in small portable computers for storing data files that need more frequent updating.

A few distinguishing technical features further define applications for the two types of flash storage, especially for PCMCIA cards. Memory-only cards offer the possibility of program execution in place (XIP); in contrast, a program stored on an ATA card must load into system memory before execution. You can boot from an ATA card, however, and run common disk-utility and data-compression software. Depending on the FFS software, you may be able to do those things with a memory-only card. The key is using software that emulates disk operations at the sector level, such as M-Systems's TrueFFS and Datalight's CardTrick.

With or without hardware-imple-



**DiskOnChip from Eurom holds as much as 16 Mbytes of data in flash memory. The multichip module also contains a replacement BIOS, hardware, and firmware that make the device emulate a conventional disk drive.**

mented disk emulation, flash-storage devices usually outperform disk drives (Ref 1). Without a disk's track-seek and rotational latencies, flash provides almost instantaneous data access. Flash is somewhat slow in writing, but its read rates are comparable to disk's, and most application programs read data far more often than they write. Consequently, poor write performance isn't usually a problem with flash and flash's short access time usually hides that performance. Flash also consumes less power and is more rugged than a disk drive.

With advances in flash-IC technology, even slow write rates are improving. For example, Intel's 28F016SA 16-Mbit flash chips include two 256-byte RAM buffers that increase the sustained write rate to 430 kbytes/sec—about four times the rate of earlier, 4-Mbit chips. When you use the chips in ATA cards, interleaving word writes to the two buffers and among the chips can increase the rate to 850 kbytes/sec—nearly double the component rate. For now, however, Intel's ATA cards still use older, 8-Mbit flash chips.

Toshiba's (Irvine, CA) NAND EEPROM flash chips address the write problem by featuring both fast erase and write times. Earlier flash ICs for disk-emulation applications—notably those from SunDisk and SST (Sunnyvale, CA)—had boosted erase speed.

The Toshiba, SST, and SunDisk chips aren't byte-addressable, like traditional flash ICs. However, their use in disk emulation, with 512-byte sectors, makes byte-by-byte access unnecessary.

In some flash chips, an "erase suspend/resume" feature minimizes the performance effects of erasing. Flash ICs from AMD, Intel, and Toshiba, for example, temporarily suspend an erase operation in one erase block to allow a read or a write in another block. Given that an erase operation can take up to 1 sec in some chips, the feature offers convenience to users of flash-based portable computers. Time-critical embedded applications, however, may find it essential.

### Every size and shape

Although most flash-storage products are PCMCIA cards, numerous other sizes and shapes are available. PC add-in boards fill a need for high speed and ruggedness when portability isn't a requirement. Embedded applications can use tiny boards for PC/104 and Extremely Small Package systems. For applications requiring ruggedness, package types range from shirt-pocket-sized cartridges to mil-spec modules.

Eurom's DiskOnChip (Ref 2) puts a flash disk into a single IC package. Useful for embedded-PC applications, DiskOnChip includes not only flash memory, but also a disk-emulation



# Reliable power— the whole idea behind our linears.



**Condor's International Plus® linear power supplies offer price, performance and full agency approvals.**



We have the combination you've been looking for—quality, reliability, value and complete agency approvals, including UL1950 without D3 deviation, IEC950 and VDE0871 Level B EMI. Condor has more approved linears in stock than anyone in the industry (including more than 30 models in IEC medical configuration). International Plus linears feature:

- 115 models (single- and multi-output)
- 7 power levels (3 to 288W)
- Worldwide AC input ranges
- OVP on all 5V outputs
- Hermetically sealed power transistors
- MTBF 200,000+ hrs. per Mil Hndbk 217E
- 2-hour burn-in with cycling (8 hours on

medical versions)

- Computerized testing (data sheets furnished)
- 3-year warranty—longest in the industry
- 30-day FREE evaluation (call for samples)

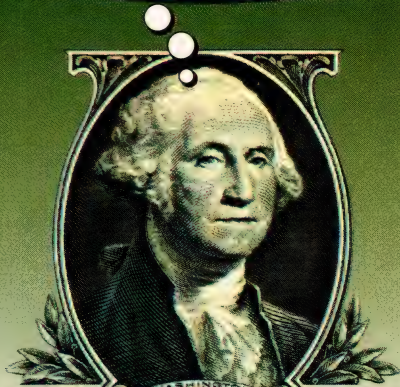
For world-class reliability and performance with great pricing and quick turnaround, call Condor—the leader in linear D.C. power supplies.

**WORLD CLASS RELIABILITY**  
**CONDOR**

Condor D.C. Power Supplies, Inc. • 2311 Statham Parkway, Oxnard, CA 93033 • (805) 486-4565 • 1-800-235-5929 (outside CA)  
FAX (805) 487-8911 • Send for our catalog, or see us in EEM.



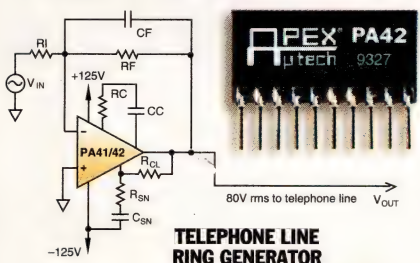
# Big Performance? Small Price? Think Apex For Power Amplifiers.



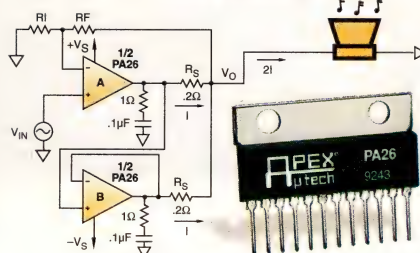
## KEY FEATURES/KEY SPECIFICATIONS

Part #	V <sub>SS</sub>	I <sub>O</sub>	V <sub>CM</sub>	V <sub>SAT</sub>	PKG	\$/10K
PA26	5V-40V	2.5A x 2	-V <sub>S</sub> -3V	1.8V @ 1.0A	SIP <sup>1</sup>	\$3.45
PA21M <sup>2</sup>	5V-40V	2.5A x 2	-V <sub>S</sub> -3V	3.5V @ 2.0A	TO-3 <sup>1</sup>	\$39.54
PA42	100V-350V	120mA	±V <sub>S</sub> -12V	10V @ 40mA	SIP <sup>1</sup>	\$13.60
PA41M <sup>2</sup>	100V-350V	120mA	±V <sub>S</sub> -12V	10V @ 40mA	TO-3 <sup>1</sup>	\$46.62

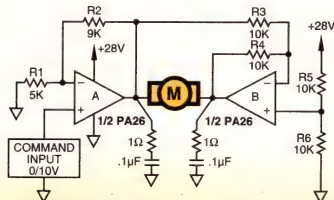
<sup>1</sup>The TO-3 is a hermetic package; the SIP is a non-hermetic package  
<sup>2</sup>"M" designates hi-rel military grade



TELEPHONE LINE  
RING GENERATOR



5A AUDIO PARALLEL CONNECTION



BIDIRECTIONAL SMALL MOTOR DRIVE



**APEX MICROTECHNOLOGY CORPORATION**  
 5980 N. Shannon Road, Tucson, AZ 85741-5230  
 For Product Information or Apps Assistance Call  
 1-800-862-1015 or FAX (602) 888-3329  
 Deutschsprachig 0130 81 3599

AUSTRALIA/N.Z. (08) 277 3288  
 BELGIUM/LUX (323) 458 3033  
 CANADA (613) 592 9540  
 DENMARK (45) 52 24 4888  
 DEUTSCHLAND (6172) 488510  
 ESPAÑA (1) 530 4121  
 FRANCE (1) 69 86 92 89  
 ISRAEL (3) 9345171  
 ITALIA (2) 6640 0153  
 INDIA (212) 339836  
 NEDERLAND (10) 451 9533  
 NORGE (2) 50 06 50  
 ÖSTERREICH 505 15 220  
 REP. S. AFRICA (021) 23 4943  
 SCHWEIZ (0049) (6172) 488510  
 SVERIGE (8) 795 9650  
 TURKIYE (1) 337 2245  
 U.K. (844) 278781

**CIRCLE NO. 64 in US**  
**CIRCLE NO. 65 in EUROPE**

## FLASH DISK

controller (which includes flash-control firmware) and a replacement BIOS. Eurom claims you can add flash disk to a system simply by replacing a BIOS ROM. DiskOnChip comes with storage capacities from 1 to 16 Mbytes.

Whether flash memory can successfully compete against higher capacity, general-purpose disk drives remains to be seen. At high capacities, flash's advantages of ruggedness, compactness, and speed run up against disk drives' one big advantage—much lower cost/megabyte. And, even though flash's cost/megabyte is dropping, disk drives are keeping pace.

Nevertheless, disk makers are planning for a future that includes flash, whether in mainstream storage products or in specialty products only. Alliances between disk manufacturers and flash suppliers include Seagate and SunDisk, Conner Peripherals (San Jose, CA) and Intel, Quantum and SST, and Maxtor and M-Systems.

Most disk manufacturers, in fact, view themselves as storage companies, not just disk companies. And, appar-

ently, they don't view flash storage as just a flash in the pan. **EDN**

## References

1. Legg, Gary, "Flash memory challenges disk drives," *EDN*, February 18, 1993, pg 99.
2. Legg, Gary, "Disk-on-a-chip replaces BIOS EPROM and stores 16 Mbytes of data," *EDN*, November 25, 1993, pg 217.
3. Dipert, Brian, and Markus Levy, *Designing with Flash Memory*, Annabooks, San Diego, CA, 1993.

You can reach Executive Editor Gary Legg at (617) 558-4404, fax (617) 558-4470.

## VOTE

Please use the Information Retrieval Service card to rate this article (circle one):

High  
Interest  
592

Medium  
Interest  
593

Low  
Interest  
594

## LOOKING AHEAD

Expect prices for flash-memory ICs to fall, perhaps dramatically, in the next few months. Many flash manufacturers geared up for large sales to manufacturers of personal digital assistants (PDAs), but the PDA market has yet to take off. As a result, a short-term flash surplus is possible.

The trend toward disk-emulation flash storage will continue. More disk-like products will be available, and designing your own will become easier. The DiskOnChip controller, an IC that now controls Eurom's DiskOnChip flash-storage module, will soon be available to OEMs. The chip provides a disk interface and includes flash-file-system firmware that works with any type of flash-memory IC. In large quantities, it will sell for \$11 to \$16.

In the long term, increasing memory density will make flash chips more cost-competitive for storage applications. Some 16- and 32-Mbit devices are available, and all flash manufacturers have long-term strategies for producing higher-density ICs. SunDisk, which pioneered disk-emulation flash with a disk-like flash architecture, recently signed an agreement with NEC to jointly develop 256-Mbit flash chips by 1997.

New packaging technologies will also boost flash-storage density. Cubic Memory Inc (Scotts Valley, CA, (408) 438-1887) has developed a technology for connecting memory wafers, wafer segments, and dice in stacks. Use of the technology could put 100 Mbytes of flash memory into a PCMCIA card and increase the percentage of usable memory dice, reducing cost/megabyte. The company isn't saying how much the cost/megabyte will fall, however, and a much lower cost will be necessary to sell cards with such high capacity. The company's first flash cards are due in early 1995.



# P-CAD HELPED PUT TRIMBLE ON THE MAP.

You're never lost when you carry the SCOUT GPS™ global positioning system from Trimble Navigation. P-CAD helped Trimble's design engineers find what they were searching for – the world's most productive PCB design software. Trimble used P-CAD software to navigate through the design process, cutting time to market and positioning their new product as a market leader. P-CAD PCB design tools enjoy some unique positioning of their own, consistently ranking first in pins-per-hour benchmark surveys among independent service bureaus. In fact, compared to other PC-based systems, P-CAD software helps designers do their work in as little as half the time. Take P-CAD Master Designer™ for example. It includes enhanced auto-dimensioning so designers can document



their work without mastering a separate mechanical CAD system. P-CAD offers a complete line of software tools for DOS, Windows™ and UNIX® platforms. For the name of your nearest P-CAD reseller, call or fax us today. And to help you map out your own winning design strategy, we'll send you a free copy of our booklet, "P-CAD – Productivity Across the Board." In today's competitive world, you could be lost without it.

**France:**

Tel: (1) 49 65 96 97

Fax: (1) 49 65 95 31

**Germany:**

Tel.: 0 69 / 6 64 00 80

Fax: 0 69 / 6 66 67 06

**U.K.:**

Tel: 049 445 9500

Fax: 049 445 9922

*More Productivity —  
Across The Board*

**p-cad®**  
From ALTUM, An IBM Company



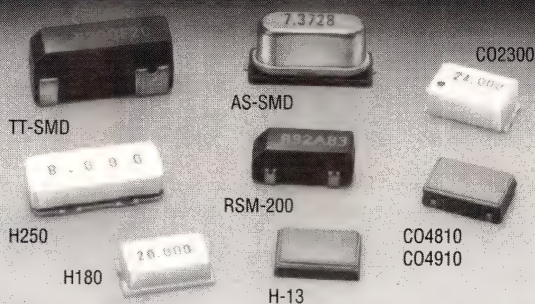
WESCON BOOTH # 2463

**SPECIFY  
RALTRON.**

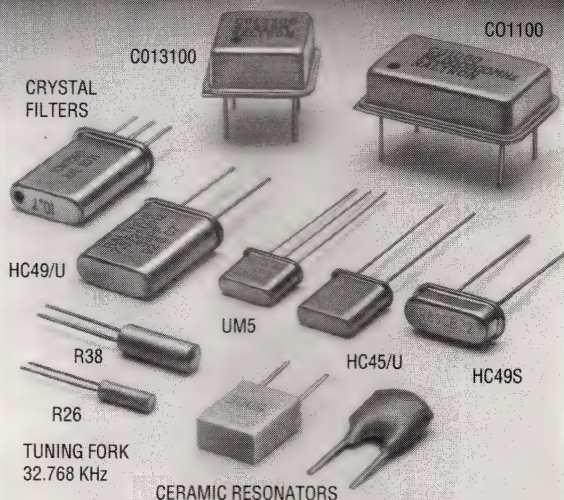
**BECAUSE  
LITTLE  
THINGS  
MEAN  
A LOT.**

# RALTRON

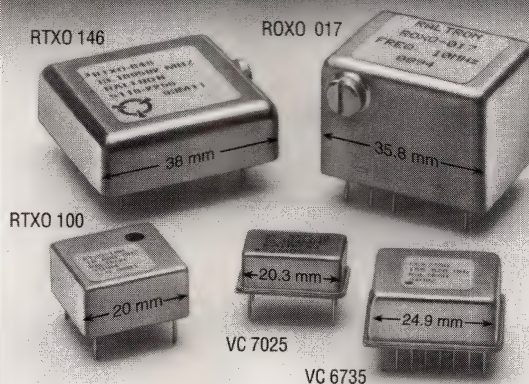
## SURFACE MOUNT CRYSTALS AND CRYSTAL OSCILLATORS



## MICROPROCESSOR CRYSTALS / CLOCK OSCILLATORS / CERAMIC RESONATORS / TUNING FORK CRYSTALS / CRYSTAL FILTERS



## VCXO's, TCXO's AND OCXO's



Frequency Range:	VCXO's:	.5 MHz - 400 MHz
	TCXO's:	1 MHz - 50 MHz
	OCXO's:	1 MHz - 50 MHz
Frequency Stability:	VCXO's:	from $\pm 15$ ppm
	TCXO's:	from $\pm 0.4$ ppm
	OCXO's:	from $\pm 2 \times 10^{-9}$ ppm
Output Options:	HCMOS, CMOS, TTL,	
	Clipped Sinewave, ECL	

## CRYSTAL UNITS

Microprocessor crystal units

Microprocessor crystal units

HC-49 short (AT strip)

Microprocessor crystal units

surface mount-

"TT-SMD" family

AT strip crystal units-

cylindrical package

Tuning fork quartz crystal units

32.768 KHz

High accuracy crystal units

Crystals for pagers

## OSCILLATORS

Clock oscillators

TTL compatible

Clock oscillators

HCMOS compatible

Clock oscillators

surface mount

Clock oscillators

enable/disable

Clock oscillators

dual output

Clock oscillators

ECL compatible

Temperature compensated

crystal oscillators - TCXO

Oven controlled crystal

oscillators - OCXO

Voltage controlled crystal

oscillators - VCXO

## FILTERS

Monolithic crystal filters

## CERAMIC RESONATORS

Ceramic resonators-

200 to 800 KHz

Ceramic resonators-

2.000 to 12.000 MHz

# RALTRON

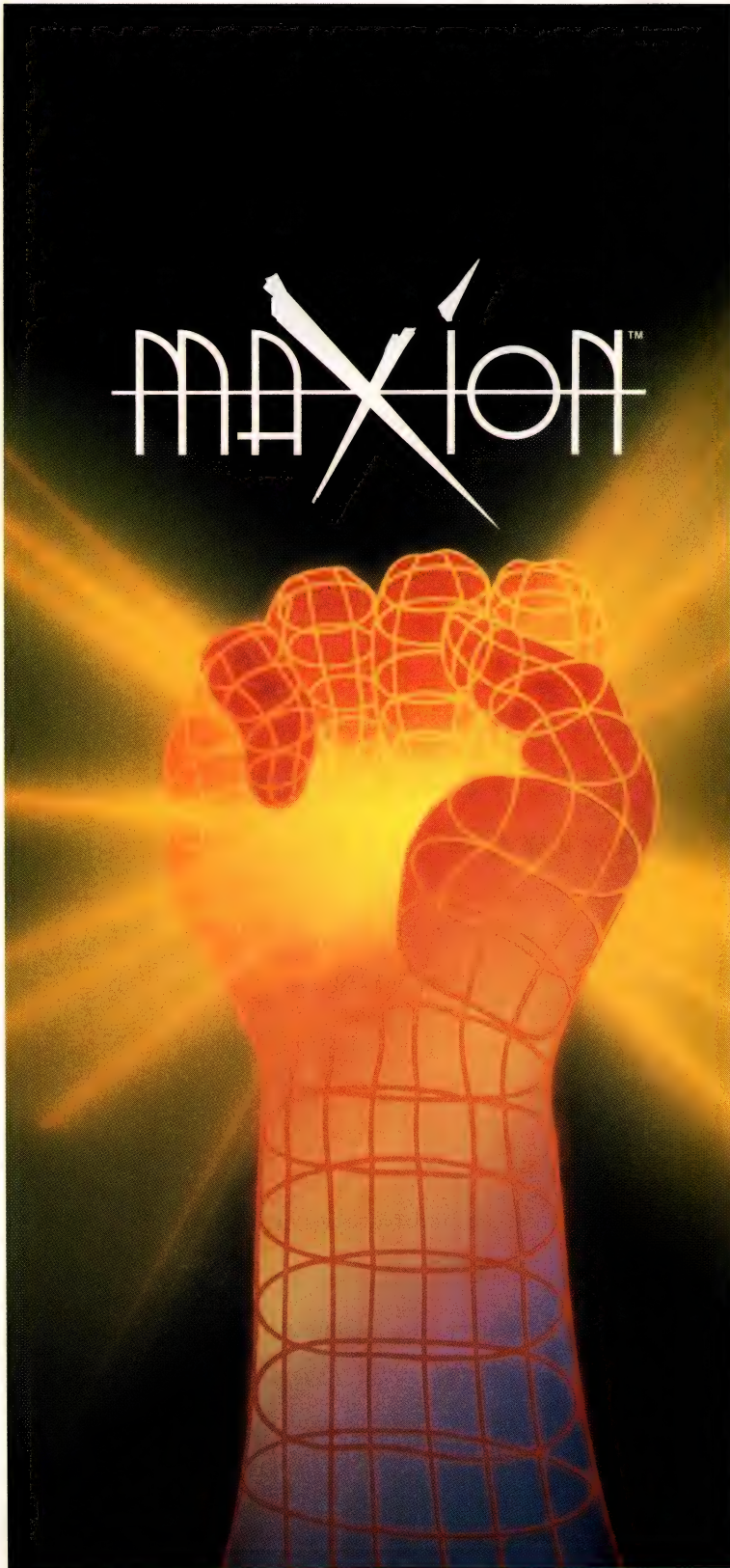
**RALTRON  
ELECTRONICS  
CORP.**

2315 NW 107 AVENUE  
MIAMI, FL 33172 USA  
FAX (305) 594 - 3973  
(305) 593 - 6033

**ONLY RALTRON  
HAS IT ALL.**



# We **POWER** Success!



- We **POWER** the world's most advanced missile testing system.
- We **POWER** the world's most sophisticated attack helicopter simulator.
- We **POWER** the world's most advanced weather radar system...NEXRAD.
- We **POWER** the world's fastest growing financial trading information system.
- We **POWER** the world's most efficient subway system...Hong Kong.

## **WE ARE CONCURRENT COMPUTER CORPORATION.**

Real Time and Beyond...multimedia, interactive video, medical imaging and mission critical on-line transaction processing ...all with our MAXION™ multiprocessor system — systems that deliver all the performance and power you pay for and demand in an open system environment.

Experience MAXION multiprocessing power for yourself. For a free CD-ROM demo, call your local Concurrent office in England at 753-534511, in France at (1) 30 85 37 00 or in Germany at 89-856030 or write to us at Concurrent Computer Corporation Ltd., 227 Bath Road, Slough, Berkshire, SL1 4AX, England.



POWER. **MAXION**™ POWER!

© 1994. MAXION is a trademark of Concurrent Computer Corporation.





**Our chip caps fit in  
a pager so small, it comes  
clipped to a 4-inch belt.**

These days, when design engineers think big, they're usually thinking *small*. So they need highly miniaturized components like Murata 0402 ceramic chip capacitors. Murata has led the world in setting standards for quality and miniaturization in chip capacitors. So it should be no surprise that the world's largest manufacturer of ceramic capacitors introduced the smallest size currently available, the 0402. Our array of capacitors includes monolithic ceramic capacitors, microwave capacitors, ceramic

disc capacitors and variable capacitors. And whether your design includes high voltage or high frequency applications, or requires superior performance and stability under high temperatures, you should depend on the quality of Murata capacitors. Especially when you're designing a product to go on the wrist, instead of the waist. For more information, call **1-800-831-9172, ext.150**.



**A small part  
in your success**



# HIGH-SPEED CONNECTORS' ELECTRICAL PROPERTIES ECLIPSE MECHANICAL TRAITS

**CHARLES H SMALL, SENIOR TECHNICAL EDITOR**

**A**n old mariner's maxim, "Keep an even strain," applies equally well to electronics as it does to handling the lines on a sailboat. Every increase in integration, doubling of bus width, and increase in system-clock speeds throws a terrible strain on interconnections.

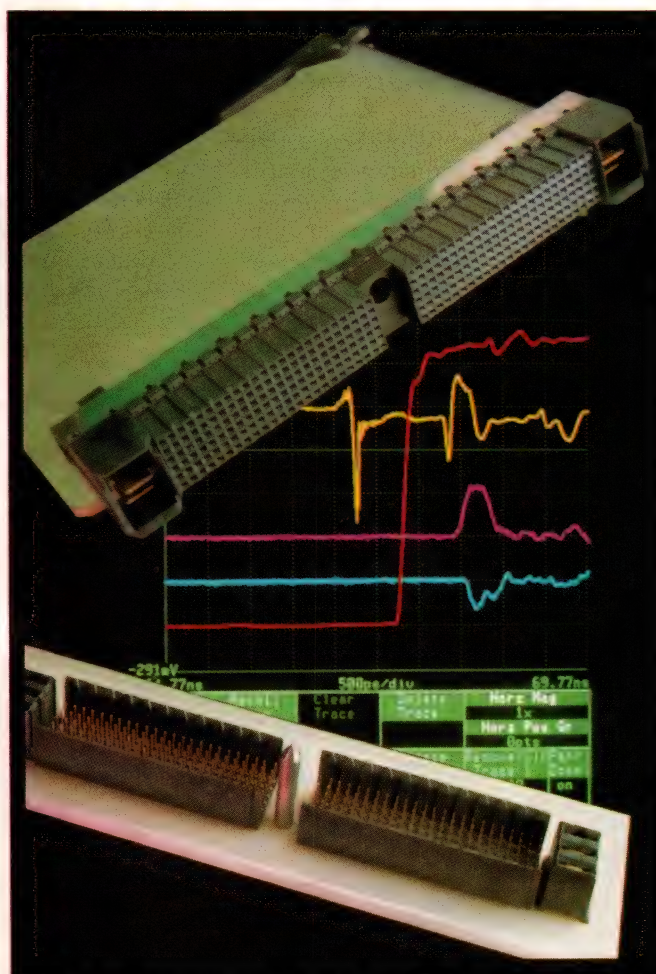
Inexorably, increasing bus widths and system-clock speeds pull connectors in two directions at once. On the one hand, connectors must pack more and more signal pins into smaller and smaller spaces. On the other hand, the increasingly short rise times and higher power levels of those signals mandate more shielding to reduce crosstalk.

Faster rise times and wider buses have changed all the old rules of thumb. Where you could once spec connectors by the seat of your pants, now you must rigorously analyze connectors.

Without proper interconnections, faster devices don't run faster; they just generate more noise.

As system clock speeds are passing the magic 50-MHz milestone, signal rise times are doing the limbo underneath 1 nsec. The number of parallel lines that have to be routed have doubled, redoubled, and doubled again. Consequently, the power to drive longer backplanes and cable runs, as well as the number of lines switching at once, have all increased. These trends, taken singly or together, are prescriptions for noise and crosstalk.

Connectors used to be innocuous components, fungible items with simple properties. All connector brands were pretty much the same, and you could solder them on as an afterthought. But now,



**Key signal-integrity performance measurements you need to make when evaluating digital board-to-board interconnections include time-domain reflections (yellow), transmitted signal (red), and backward and forward crosstalk (magenta and blue, respectively). (Photo courtesy Teradyne Connector Systems)**



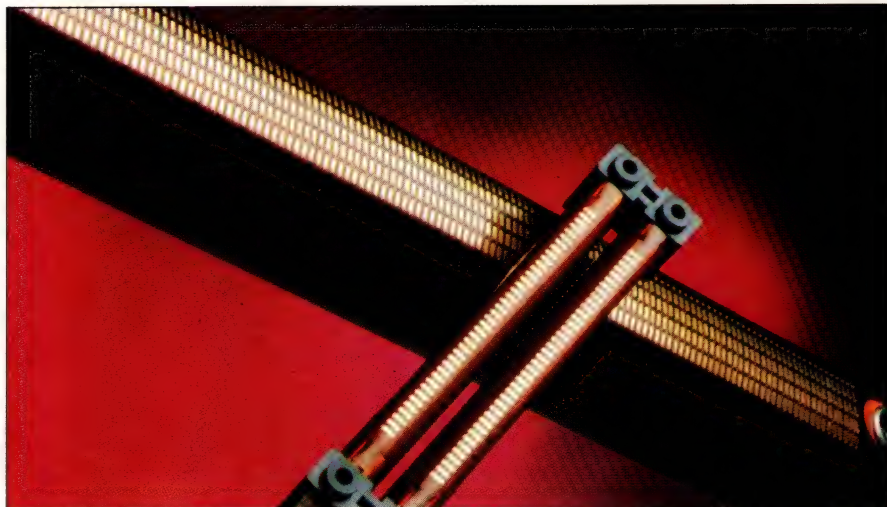
## HIGH-SPEED CONNECTORS

the physics of the connector is having a profound effect on signal integrity.

Your best bet is to do extensive and thorough simulations of your interconnections up front to avoid designing yourself into a corner. If you leave connectors to the last, you will likely find yourself using expensive connectors and incurring high assembly costs. After all, the connector industry always has had connectors for high-speed systems: They call such connectors RF and microwave connectors.

Where old-fashioned board-edge connectors cost around \$0.005 per signal line, RF and microwave connectors cost several dollars or more per signal line. The more stringent your specifications for signal integrity and crosstalk, the more your connectors will resemble RF and microwave connectors both in performance and price. For example, many high-performance workstation connectors cost \$0.10 to \$0.25 per signal line.

3M's SCI connectors offer exceptional high-speed performance. Engineers employ the SCI connectors for rise times ranging from 2 nsec down to 100 psec. Although 3M's SCI connectors mate to standard pc-board header pins,



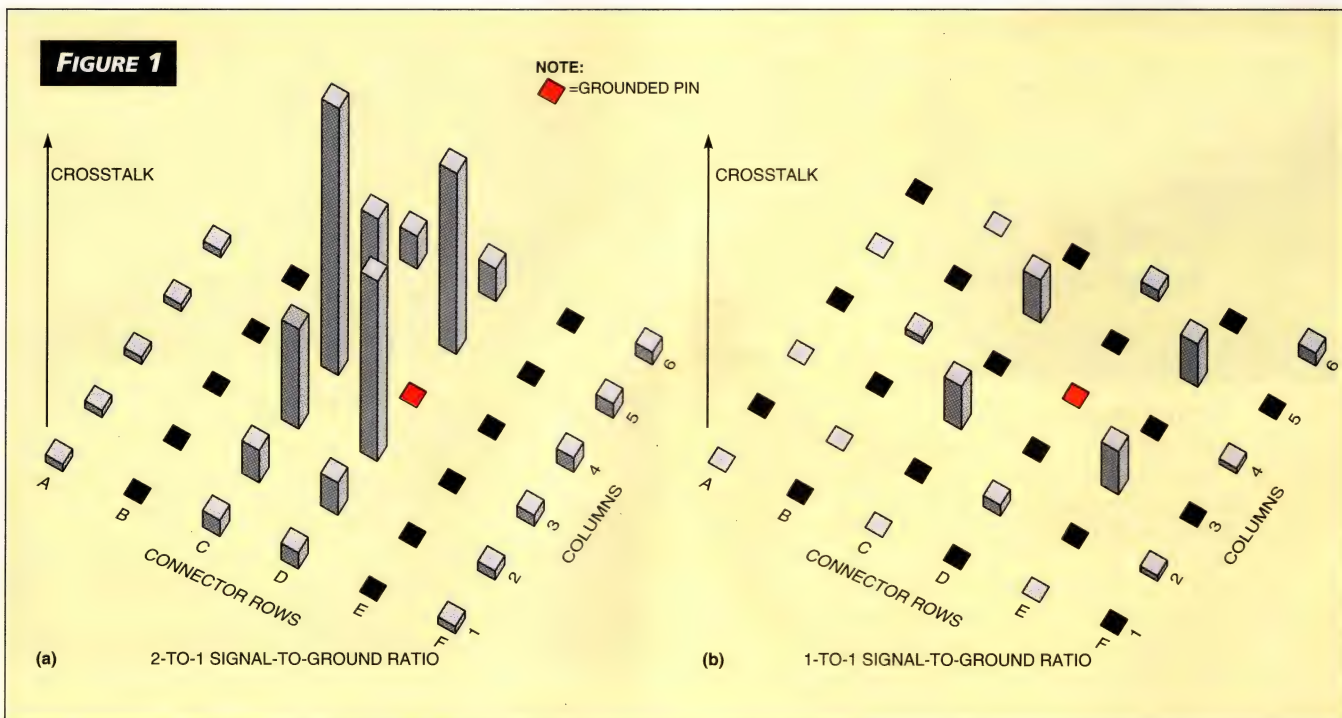
**The AMP-ASC's wraparound flexible circuit can connect as many as five rows of pads on each side of a daughterboard to a corresponding set of pads on the mother-board.**

the connectors' sockets are fully shielded. Further, the connector's sockets mate to miniature, 50 $\Omega$  coaxial cable instead of flat cable (75 $\Omega$  terminations are also possible).

The result is a connection that is quiet enough for analog signals. In fact, 3M also quotes analog specs, such as VSWR and insertion loss, for the connectors. For digital engineers, 0.5-nsec

rise-time digital signals experience less than 2% crosstalk. The company has extensive Spice models that it supplies to engineers or uses to perform simulations for customers.

However, stripping and attaching the delicate miniature coaxial cable is a specialized art employing exotic machinery such as laser wire strippers. Consequently, 3M does not sell just the



**These simulations of crosstalk in a six-row, 2-mm-grid backplane connector show a 2-to-1 signal-to-ground pattern (a) and a 1-to-1 checkerboard ground pattern (b) (black squares indicate grounds). A 1-nsec rise-time signal drives pin number D4 in both cases. (Courtesy Teradyne Connector Systems)**



# Power Tools

Highlight critical paths across windows

QuickBoolean entry embedded in schematic symbol

Simulation results dynamically displayed on schematic

Path timing met via timing driven placement

## The Fastest Tools for the World's Fastest FPGAs

The fastest **time-to-market** is attained when designers use productivity Power Tools for QuickLogic's WildCat™ Series — the world's fastest FPGAs.

QuickLogic toolkit owners find instant productivity with the intuitive interfaces of both our Windows and Sun packages. These tools feature 100% automatic place and route using advanced timing-driven placement that eliminates time-consuming intervention with hand tools.

### Great Power Tools Drive Great FPGAs

Our pASIC® family's low cost WildCat Series provides a wealth of interconnect resources for an environment where design iterations have no effect on pin-out and minimal effect on timing. Even the use of all I/O and flip-flops will consume only 5% of the available interconnect. And your designs will *always* route, even with all pads fixed.

At the heart of QuickLogic's software is a tool called SpDE™ (Speedy), and it lives up to its name by running 1K usable-gate designs in under 2.5 minutes. And our toolkit also includes a powerful Technology Mapper, which improves *any* synthesized

result, including VHDL and Verilog, with up to 60% reduction in silicon and a performance increase of 25%.

If you need more convincing that QuickLogic delivers a superior time-to-market design solution, just fax us your business card. Be one of the first 100 faxes and receive a **FREE** Evaluation Kit, complete with all the tools you need to enter, simulate and analyze your design.

To learn more about our Power Tools, fax us at **408-987-2012** or call **1-800-842-FPGA (3742)** for a QUICK response.



**QUICKLOGIC**

*We Live Up To Our Name*

**1-800-842-FPGA(3742) • European Fax: +49 (89) 857 77 16**

©1994 QuickLogic Corporation. pASIC is a registered trademark and SpDE and WildCat are trademarks of QuickLogic Corporation. All other trademarks are the property of their respective companies.



## HIGH-SPEED CONNECTORS

connectors; it sells only complete custom cable assemblies. A typical 50 $\Omega$  assembly having five miniature coaxial cables, each a foot long, terminated at one end with a 10-position connector, costs \$23.35 each.

Instead of using shielded connector sockets and coaxial cable, grounding signal pins is an alternative for reducing crosstalk. In high-speed applications, engineers commonly sacrifice as much as one-quarter of their signal pins to grounding.

Fig 1 shows simulations of crosstalk in a six-row, 2-mm-grid backplane connector at two signal-to-ground ratios: a 2-to-1 signal-to-ground pattern (Fig 1a) and a 1-to-1 checkerboard ground pattern (Fig 1b).

A 1-nsec rise-time signal (10 to 90%) drives pin D4 in both cases. Black squares indicate contacts assigned to ground. All other lines terminate in 65 $\Omega$ . In this example, adding grounds dramatically lowers overall crosstalk by reducing both the number of signal pins that pick up crosstalk and the level of the crosstalk.

The tradeoff obtains lower crosstalk at the expense of interconnection density: 38.1 signals/in. for the 1-to-1 signal-to-ground pattern vs 50.8 signals/in. for the 2-to-1 pattern.

To help engineers optimize portions of a backplane for signal-integrity and interconnect-density requirements, some connector vendors offer both standard-signal-pin and internally shielded versions of their backplane connectors, which mate interchangeably with the same backplane-connector half.

### No model? no simulation

The starting point for simulating connectors is a good Spice model. Indeed, the Spice model has become a "checkoff" item for many connector shoppers. But there are Spice models, and then there are *Spice* models. For some applications, you can model a connector as an array of simple capacitors that slightly round off signal edges. But, for accurate models of large, high-speed connectors, you need subtle Spice models whose listings can run for

more than 100 pages. Such models must account for nonlinear behavior and crosstalk. Including all possible crosstalk terms for a large connector can alarmingly balloon a Spice listing.

So, you have two possible tacks. You can subcontract a connector company to design your interconnection system. A relative handful of companies, including Amp, Molex, Teradyne, and 3M, has considerable, hard-won, in-house expertise in high-speed connectors. This expertise is available as application assistance or on a fee basis, depending on the company's policy and your needs.

The other tack is to use the connector companies' Spice models as starting points for your own in-house simulations. The decision on which path to take rests more on such imponderables as your company's corporate culture than it does on engineering issues.

### Kiss sunk costs goodbye

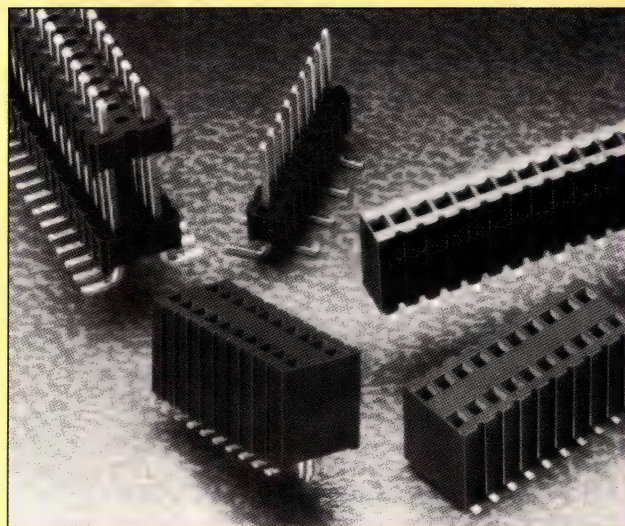
Your company may want to do as much "congruent engineering" as possible to shorten development cycles. Or

## MECHANICAL SPECS PROFOUNDLY AFFECT YOUR CONNECTOR CHOICE

Because the connector companies have catered to their largest customers, large companies, such as IBM, have long set the de-facto mechanical standards for everyone's connectors. For example, the current de-facto standard for insertion force is about 1 oz/contact. However, as the number of contacts per connector goes up, the total insertion force cannot go up proportionally because you would not be able to insert the boards.

The easiest way to make a pair of connectors easier to mate is to decrease the contact pressure between their contacts. Not too long ago, the de facto standard for "normal," or perpendicular, forces between the mating surfaces of connectors was 100g. Now that low-insertion-force connectors are necessary, the standard-setting large companies are satisfied with 50g. Connector companies have devoted much effort to this dilemma. Molex, for example, can deliver as high as 75g of normal force/pin in a low-insertion-force connector.

More subtly, mechanical engineers designing connectors speak of hertz forces. At a microscopic level, two mating surfaces, however smoothly polished or coined, actually have tiny peaks and valleys. The physical contact takes place only between the peaks of the two surfaces. Therefore, the surface finish and material of the surfaces have important effects on the quality and endurance of the electrical contact. After performing an abstruse calculation, mechanical engineers quote hertz forces in so many thousands of lbs/sq in. (kpsi). Absent a mechanical-engineering degree, your best bet is to



**Stacking connectors use a lot less metal to get a signal from one board to another compared to a motherboard, yielding good electrical performance at low cost. (Courtesy Samtec)**

nod wisely and accept the mechanical engineer's opinion on how many thousands of lbs/sq in. are adequate for your application.



# Clip and Save!



No.	Product	Series	Type	Samples	Typical Circuit
1	Solid Chip Suppressor	NZ	1608		
			2012		
			3216		
			4516		
2	Inductor	NW	2520		
			5650		
3	Common Mode Choke	M	520		
			530		
			540		
		CZ	5745		
			5745		
			5745		
4	Leadless Power Inductor	P+IZ	9x7x5		
			12x10x6		
		P+IL	9x7x5		
			12x10x6		
5	3-Terminal Noise Suppressor	E-T	4525		
6	3-Terminal Chip Capacitor	E-C	3216		

Project  
1000,  
Tue

Call  
re.

Whether you're working with camcorders, cellular phones or electronics notebooks, signal lines or power lines, normal mode or common mode, TOKIN EMC components provide exceptional functionality that can boost your PC boards to a powerful new performance level.

## TOKIN

### Tokin Corporation

International Sales Department  
Sumitomo Seimei Sendai Chuo Bldg., 4-6-1, Chuo, Aoba-ku,  
Sendai 980, Japan  
Phone: 022-211-1281 Fax: 022-211-0975  
Korea Representative Office  
#602, Champs-Elysees Bldg., 889-5, Daechi-Dong, Kangnam-gu,  
Seoul, Korea  
Phone: (2) 569-2582 ~ 5 Fax: (2) 544-7087

### Tokin America Inc.

155 Nicholson Lane, San Jose, California 95134, U.S.A.  
Phone: 408-432-8020 Fax: 408-434-0375  
Chicago Branch  
9935 Capitol Drive, Wheeling, Illinois 60090, U.S.A.  
Phone: 708-215-8802 Fax: 708-215-8804

### Tokin Electronics (HK) Ltd.

Unit 705-707, Chiwan Tower, Park Lane Square, 1 Kimberly Rd.,  
Tsimshatsui, Kowloon, Hong Kong  
Phone: 730-0028 Fax: 375-2508  
Taiwan Liaison Office  
Phone: (02) 7728852 Fax: (02) 7114260  
Singapore Branch  
Phone: 2237076 Fax: 2236093, 2278772  
Shanghai Liaison Office  
Phone: 21-433-4488 Ext. 80809 Fax: 21-433-3265 Ext. 80809

### Tokin Europe GmbH

Knorstr. 142, 80937 München, Germany  
Phone: 089-311 10 66 Fax: 089-311 35 84



## HIGH-SPEED CONNECTORS

your company may view software development as a sunk cost that unquestionably deserves to be recovered. (This lack of understanding of basic accounting has put a lot of bad software on the market at high prices.) In these cases, turning the connector development over to a connector company may make the most sense in the short term.

But perhaps your company views Spice simulation as an inexpensive investment in hardware R&D—an investment that pays big returns in the form of a low-cost, reliable, and manufacturable product. In this case, refining your own Spice models so that they accurately predict connector performance in your system could be the way to go in the long term.

Indeed, in the past, connectors were solely the purview of mechanical engineers. Lately, connector companies have had to learn how to talk about electrical properties to electronic engineers. So mechanical engineers now discuss bandwidth and percentage

crosstalk. Similarly, electronic engineers have had to learn how to talk about mechanical properties with connector companies.

### On your own

However, not all connector companies can provide the same level of application support as, say,  $\mu$ P or analog-IC companies can. The connector industry is cost-competitive. Many companies are doing all they can simply to mold plastic, shape contacts, and assemble connectors as rapidly as possible. The profit margins in the industry simply do not allow connector companies to spend as much on R&D as do semiconductor companies. So, in general, be prepared to do your own signal analyses.

Curiously, connector companies have not spun off commercial versions of their high-speed connectors for military systems. Military designers often need high-density connectors. Such MIL-SPEC connectors require thick gold plating, durable materials, and exotic

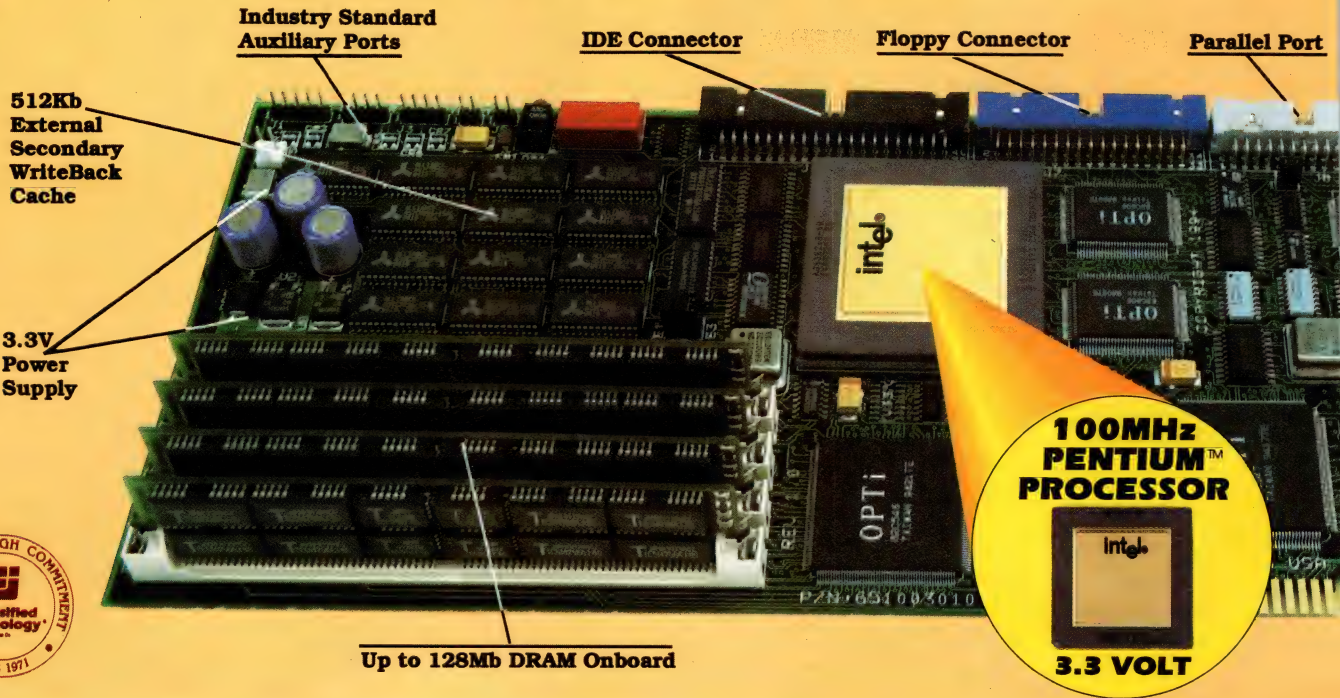
finishes. Military connectors do not use the pins and sockets of DIN-style connectors. The contacts of military connectors resemble miniature tuning forks and blades, with the tuning forks on the backplane and the blades on the daughterboards. Military connectors have progressed from the early 40-pin SEM A connector to connectors having 200 to nearly 400 contacts within a standard 4.55-in. footprint.

Molex is one connector company that *does* make a commercial fork-and-blade connector. Molex's Low-Force Helix connectors use a split-beam contact that mates with a slightly twisted male blade, minimizing the abrupt ramp angle of pin-and-socket contacts. This connector exhibits insertion force of 1 oz/contact, 75g normal force/contact, and hertz forces of 225,000 lbs/sq in. (225 kpsi).

The twisted male blade provides additional mechanical strength, since it is more substantial than the conventional male pins in most 0.050-in. center connectors. The connectors work at

**Fault  
Tolerant  
Offering**  
Next Page

# 100MHz PENTIUM™ PRO Passive Backplane Single Board Computer





## FOR FREE INFORMATION...

For free information on the connectors discussed in this article, circle the appropriate numbers on the postage-paid Information Retrieval Service card or use EDN's Express Request service. When you contact any of the following manufacturers directly, please let them know you read about their products in EDN.

### Advanced Interconnections

West Warwick, RI  
(401) 823-5200  
**Circle No. 413**

### Amp Inc

Harrisburg, PA  
(717) 564-0100  
**Circle No. 414**

### Berg

Emigsville, PA  
(717) 764-7200  
**Circle No. 415**

### Hirose

Simi Valley, CA  
(805) 522-7958  
**Circle No. 416**

### Hypertronics

Hudson, MA  
(508) 568-0451  
**Circle No. 417**

### Molex

Lisle, IL  
(708) 969-4550  
**Circle No. 418**

### Positronic Industries

Springfield, MO  
(417) 866-2322  
**Circle No. 419**

### Samtec

New Albany, IN  
(812) 944-6733  
**Circle No. 420**

### Shin-Etsu Polymer America Inc

Union City, CA  
(510) 475-9000  
**Circle No. 421**

### Siecor

Hickory, NC  
(704) 327-5000  
**Circle No. 422**

### Teradyne Connector Systems

Nashua, NH  
(603) 889-5156  
**Circle No. 423**

### 3M, Electronic Products Components Group

Austin, TX  
(512) 984-1800  
**Circle No. 424**

### Trompeter

Westlake Village, CA  
(818) 707-2020  
**Circle No. 425**

### VOTE . . .

Please also use the Information Retrieval Service card to rate this article (circle one):

**High Interest 589**

**Medium Interest 590**

**Low Interest 591**

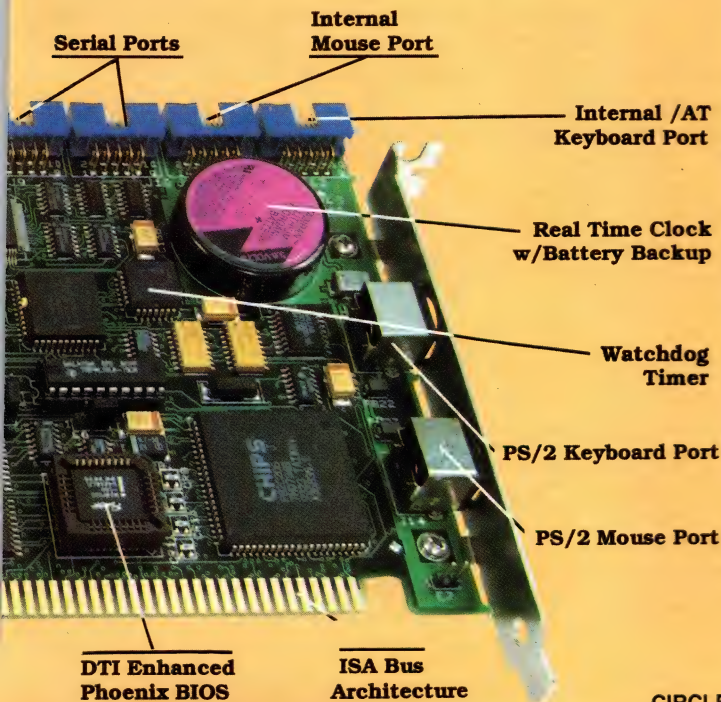
### Super Circle Number

For more information on high-speed connectors available from all of the vendors listed in this box, you need only circle one number on the postage-paid reader service card.

**Circle No. 426**

# Processor Computer Architecture

**3.3 VOLT  
LOW HEAT**



SPECIFICATIONS	CAT3010 Pentium™ Processor	CAT3001 Pentium™ Processor	CAT1070 i486™ Processor	CAT1012 i486™ Processor
100MHz PENTIUM™ 3.3 VOLT	✓			
60/66MHz PENTIUM™ 5 VOLT		✓		
50MHz 486DX & 50/66MHz 486DX2			✓	✓
33MHz 486DX/SX			✓	✓
VGA True Color w/BitBit			✓	
Up to 512Kb PROM/FLASH Disk			✓	
16Kb Internal Pipelined Cache	✓	✓		
512Kb WriteBack 2nd Cache	✓	✓		
64Kb/256Kb WriteBack 2nd Cache			✓	✓
8Kb Internal Cache			✓	✓
Up to 128Mb DRAM Onboard	✓	✓		
Up to 64Mb DRAM Onboard			✓	✓
2 Serial Ports / 1 Parallel Port	✓	✓	✓	✓
IDE/Floppy Interface	✓	✓	✓	✓
PS/2 Mouse Support	✓	✓	✓	✓
/AT-PS/2 Keyboard Support	✓	✓	✓	✓
Manufactured In-House(USA)	✓	✓	✓	✓
Powermeter 1.2 MIPS 100MHz Pentium	70.1			
Powermeter 1.2 MIPS 66MHz Pentium		44.8		
Powermeter 1.2 MIPS-60MHz Pentium		40.2		
Powermeter 1.2 MIPS-66MHz 486 DX2			28.8	26.6

**Diversified  
Technology**  
An Ergon Co.

Call us toll free for orders and information.

**1-800-443-2667**

U.S.A. - (601) 856-4121 Fax (601) 856-2888

Outside U.S.A. - (201) 891-8718/Fax (201) 891-9629

Product names are trademarks or registered trademarks of their respective companies.  
386, 486 & PENTIUM are trademarks of Intel Corp.



## HIGH-SPEED CONNECTORS

frequencies up to 1 GHz. They are available in 0.050- and 0.075-in. center models. Prices range from \$0.08 to \$0.16 per contact.

### Flexible circuits aren't cheap

Flexible-circuit connectors that have been used in military applications haven't found many commercial uses. Flexible circuitry allows improved signal integrity between multilayer boards and the connector and high contact density.

Amp, however, *has* adapted flexible circuit boards to an innovative upgrade of the edge connector. The AMP-ASC can connect as many as five rows of pads on each side of a daughterboard to a corresponding set of pads on the motherboard. The connector starts with a U-shaped plastic channel. Then, a sheet of flexible circuit board wraps around the plastic channel.

The two ends of the flexible circuit board that are inside the channel's slot bear pads that mate with pads on the daughterboard in the slot. Similarly, pads on the portion of the flexible circuit board that passes under the plastic channel mate with pads on the motherboard.

To ensure good electrical contact, the U-shaped channel has long, small-diameter springs set into longitudinal grooves on the inside of both sides of the channel, as well as along the bottom. Under pressure, the springs' coils compress and tilt slightly to the side—a behavior that the company calls "canting." Inserting the daughterboard compresses the springs inside the channel. Bolting the connector to the motherboard (using a reinforcing bar on the underside of the motherboard) compresses the springs on the bottom of the channel.

The connector handles subnanosecond rise times and provides as many as 200 matched-impedance signal lines/in. It costs \$0.10 to \$0.30 per line.

### Swords into plowshares

Despite the proven performance of high-speed military connectors, the central sticking point for their commercial use is the industry's inability to make a military connector at a commercial price. Apparently, beating today's MIL-SPEC swords (or \$400 screwdrivers) into commercial plow-

One way to reduce connector-induced problems and connector-related costs is to eliminate as many connectors as possible from your design. **Ref 1** details a Motorola VMEbus design that lowered cost by, among several stratagems, eliminating the computer's backplane and using stacking boards instead. The company had to perform extensive Spice simulations of the board-to-board connections to meet VMEbus specs without having a VMEbus backplane in the circuit.

Using board-to-board connectors instead of a motherboard is an idea that comes and goes. But stacking connectors use a lot less metal to get a signal from one board to another compared to a motherboard, giving

shares takes something more akin to alchemy than mere blacksmithing.

Instead, many of today's high-speed connectors descend from the DIN connector. The two-piece DIN connector was the first widely used alternative to the ubiquitous one-piece edge connector. The DIN connector provides a maximum of 96 contacts arranged in three rows on a 0.100-in. grid.

Before engineers became concerned with signal integrity, they evaluated connectors and backplanes against mechanical criteria. Density, their only real concern, meant simply adding more rows to two-piece connector designs. Thus, the three-row DIN gave way to four-row, high-density types, and versions having more closely spaced pins are available.

Signals still have to get into tightly spaced connector pins. So staggered pins are common in high-density connectors. Low-current signal pins aside, you can distribute your backplane's power via external top-side busing, internal copper-core busing, or combinations of these techniques.

For example, Teradyne's High Density Metric connectors are Futurebus+ compatible. They contain a six-row array of contacts arranged on a 2-mm

good electrical performance at low cost. Therefore, stacking connectors may experience yet another resurgence in popularity.

Amp's AMPMODU Metristak surface-mount connectors provide a 50-psec connection between two pc boards. The connectors signal paths are on 1-mm centers, and the board-to-board spacing is 5 mm. A 50-position connector costs \$0.10 per signal line (5000).

Samtec's RSM and HTMS series provides surface-mount sockets and headers having pins on a 0.050×0.100 grid. A mated pair measures 0.465 high. Cost for the sockets is \$0.06 per pin, and the headers range from \$0.035 to \$0.04 per pin.

grid. You can mix end-stackable signal, power, and polarizing-guidance modules in any configuration. Signal modules contain either 72 or 144 contacts. Daughterboard connectors come in two styles: standard and shielded. The finished product, costing \$0.15 per line, comes with a custom multilayer pc backplane, backplane and daughterboard connector assemblies, power busing, and a card cage. **EDN**

## Reference

1. Small, Charles H, "Shrinking devices put the squeeze on system packaging," *EDN*, February, 17, 1994, pg 41.

*You can reach Senior Technical Editor Charles H Small at (617) 558-4556 or as EDNSMALL on MCI Mail or the EDN Readers' BBS.*

## VOTE

Please use the Information Retrieval Service card to rate this article (circle one):

High  
Interest  
589

Medium  
Interest  
590

Low  
Interest  
591



# INCREASED COOLING

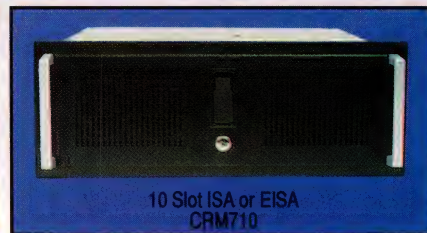
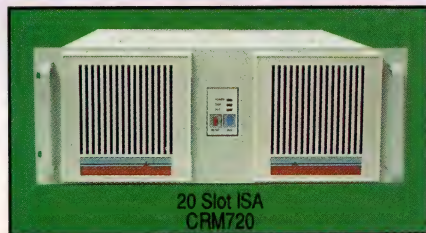
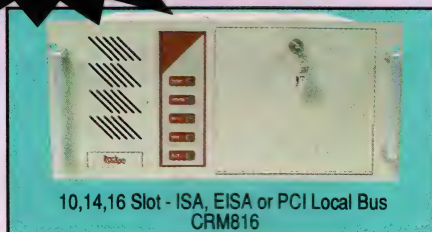
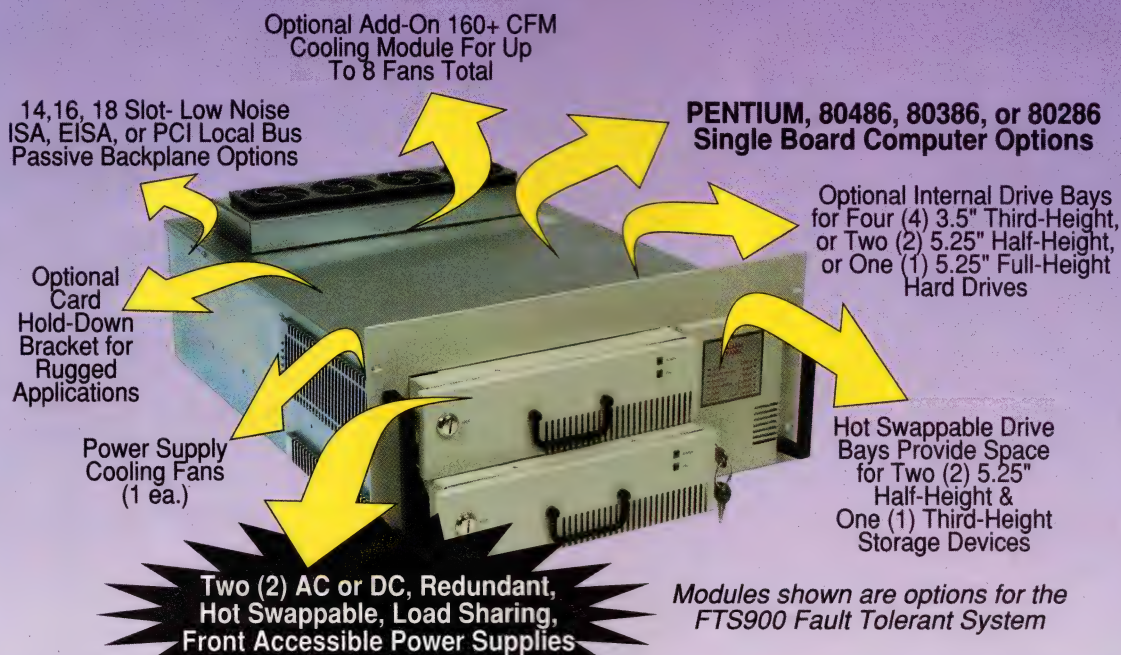
## NOW AVAILABLE

### IBM COMPATIBLE INDUSTRIAL FAULT TOLERANT RACKMOUNT COMPUTER

Choose From DTI's Selection Of PENTIUM™,  
80486™, 80386™ or 80286 Single Board Computers.  
Bus Architectures Available Include ISA, EISA & PCI Local Bus

With Diversified Technology's 19" Rackmountable Computers, you can custom configure a complete industrial system that is tailored for your application. "Pack" it with modules chosen from DTI's selection of passive backplanes, CPU cards, hard & floppy drives, as well as power supplies. Combine the "packed" rackmount with DTI's rackmountable components and "Stack" it to create a complete Industrial Computer Solution. DTI's selection of rackmount components includes: monitor enclosures, printer drawers, video/keyboard switches, keyboards w/drawer and various sizes of slides. Each DTI Rackmount Computer is UL & FCC Recognized and comes with a full one year warranty. Let DTI help you to "Pack & Stack" quickly and easily. Call for more information on DTI's rackmount family.

### REDUNDANT - HOT SWAPPABLE POWER SUPPLIES



**Diversified Technology®**  
An Ergon Co.

Product names are trademarks or registered trademarks of their respective companies. 80386, 80486 & Pentium are trademarks of Intel Corp. The Intel Inside Logo is a trademark of Intel Corporation.

Call us toll free for orders and information  
U.S.A. - (601) 856-4121 Fax (601) 856-2888  
Outside U.S.A. - (201) 891-8718/Fax (201) 891-9629

**1-800-443-2667**



# Transfer data at 500Mbytes/sec with NEC's Rambus Memory Solution



## NEC offers 16M and 18M Rambus DRAMs with interface bridges

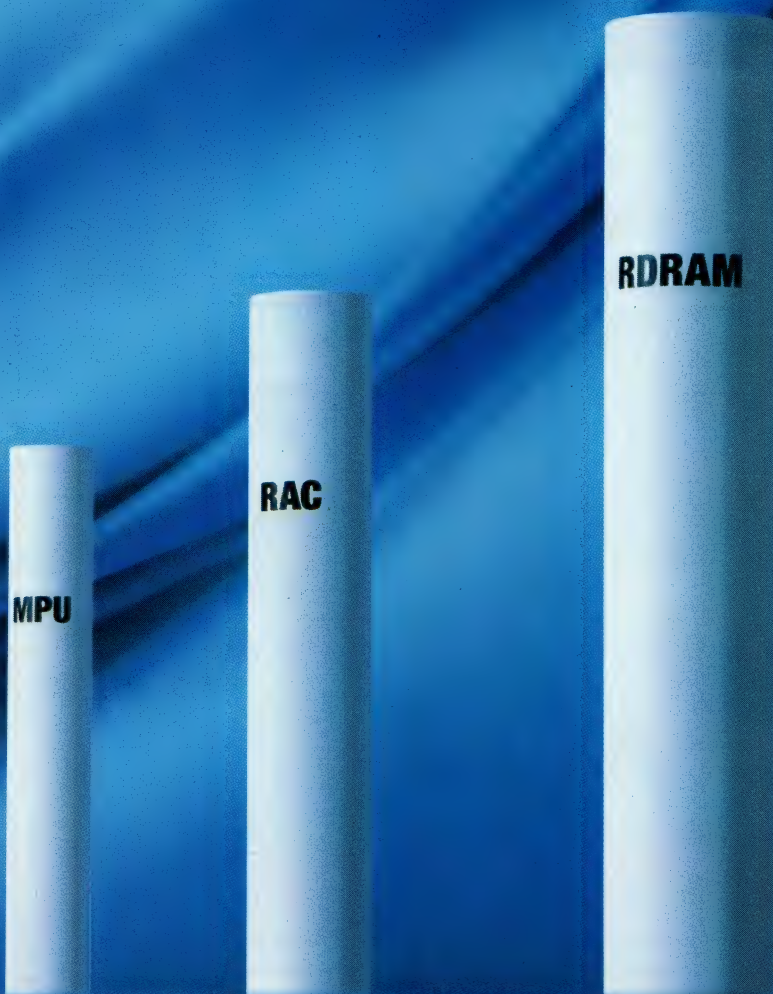
Now there's a memory to match the spiralling speed of the latest microprocessors. NEC's Rambus™ DRAM (RDRAM™) operates at 250MHz. It transfers data at the unparalleled rate of 4 billion bits per second. Superior performance makes RDRAMs the ideal graphics memory for high-end multimedia systems, desktop computers and workstations.

NEC is the first and only vendor offering 16M and 18M RDRAMs. We also provide the interface chips you need to implement the industry's most advanced memory solution.

NEC's RDRAMs are fabricated with a 0.45-micron CMOS process. They operate on 3.3V. Organizations are 2M x 8 and 2M x 9. Package options are a 32-pin Surface Vertical Package (SVP) and a 32-pin SSOP. These space-saving

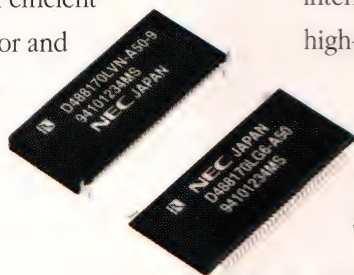
**For fast answers, call us at:** **USA** Tel:1-800-366-9782.Fax:1-800-729-9288. **Germany** Tel:0211-650302.Fax:0211-6503490.  
**The Netherlands** Tel:040-445-845.Fax:040-444-580. **Sweden** Tel:08-753-6020.Fax:08-755-3506. **France** Tel:1-3067-5800.Fax:1-3946-3663.  
**Spain** Tel:1-504-2787.Fax:1-504-2860. **Italy** Tel:02-6709108.Fax:02-66981329. **UK** Tel:0908-691133.Fax:0908-670290. **Ireland** Tel:01-6794200.  
**Fax:**01-6794081.**Hong kong** Tel:886-9318.Fax:886-9022. **Taiwan** Tel:02-719-2377.Fax:02-719-5951. **Korea** Tel:02-551-0450.Fax:02-551-0451.  
**Singapore** Tel:253-8311.Fax:250-3583. **Australia** Tel:03-8878012.Fax:03-8878014. **Japan** Tel:03-3454-1111.Fax:03-3798-6059.





package styles make RDRAMs an excellent choice for the main memory in PCs and workstations.

NEC's Rambus ASIC Cell (RAC™) is a macro for our 0.5-micron CB-C8 family. It provides an efficient interface between the microprocessor and the RDRAMs. The CB-C8 ASIC gives you true 3V operation. It also ensures safe interface with 3.3V and 5V components.



Designers of multimedia terminals and games can gain a powerful price/performance edge by combining RDRAMs with our VR4200 64-bit RISC microprocessor. The Rambus interface bridge permits easy implementation of low-cost, high-performance systems.

Whether you're designing multimedia systems, desktop computers or workstations, RDRAMs make memory-intensive applications run at 21st-century speed. For more information, call NEC today.



*Rambus, RDRAM and RAC are trademarks of Rambus Inc.*

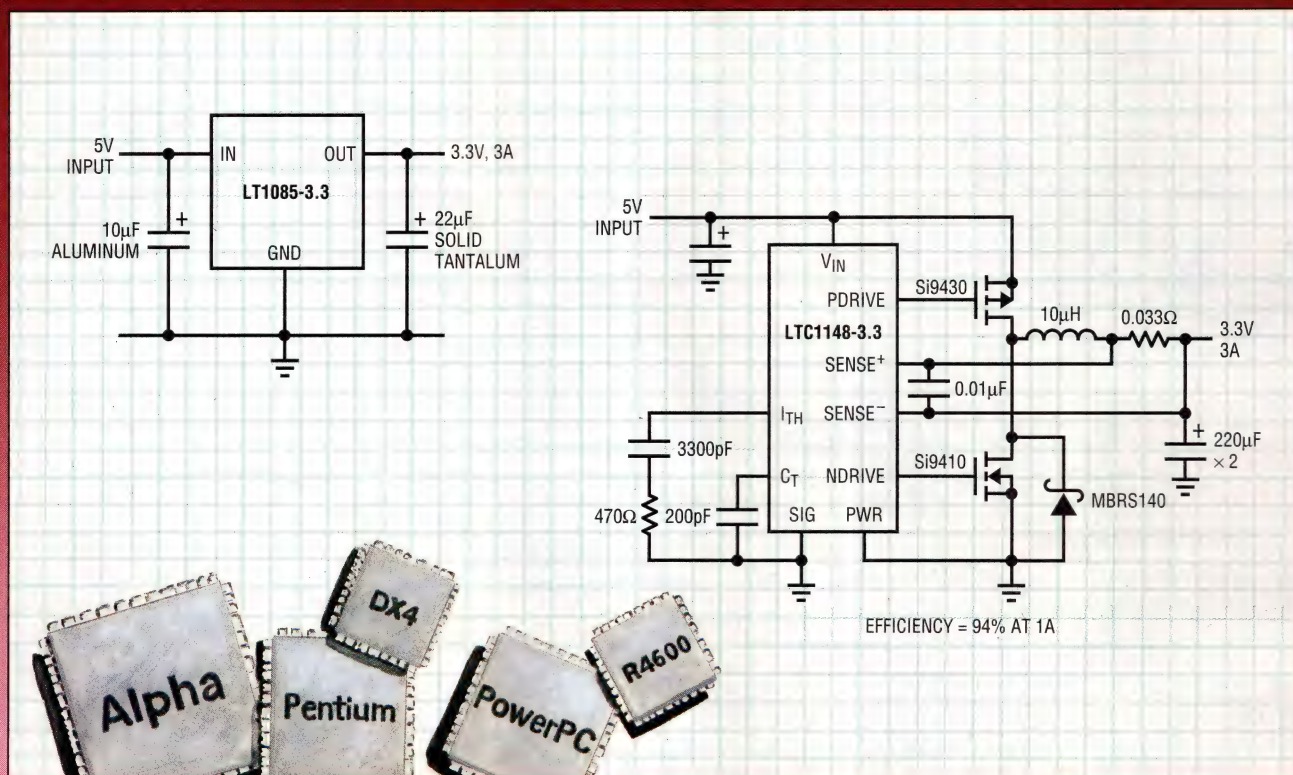
CIRCLE NO. 147

# NEC

EDN September 1, 1994 ■ 75



# 5V→3.3V: Linear or Switcher?



You have chosen your processor, now you must choose your power supply. Linear Technology provides you with the best solutions, linear regulator or switching regulator to convert from 5V to 3.3V at any current. We also allow you to tailor your output from 2.9V to 3.6V.

For highest efficiency, the LTC1148 synchronous switching regulator will convert from 5V to 3.3V at up to 10A loads with greater than 90% efficiency. Linear Technology also provides synchronous switching designs for high efficiency at currents up to 20A at 3.3V! These solutions require no heat sinks, allowing easy integration onto your CPU board.

For lowest cost, the LT1085 low dropout linear regulator provides up to 3A of load current at a

regulated 3.3V in standard TO-220 or power surface mount DD packages. Linear Technology's broad line of low dropout linear regulators supply up to 7.5A for 5V to 3.3V conversion applications. LTC also has

micropower linear regulators for low current, battery powered applications requiring the lowest quiescent current.

Linear Technology has the parts, designs and applications assistance to make your source for 3.3V

power design an easy choice. For details, contact Linear Technology Corporation, 1630 McCarthy Boulevard, Milpitas, California 95035/ 408-432-1900. For literature only, call **1-800-4-LINEAR**.

Output Current	Linear Regulator	Switching Regulator
1.5A	LT1086-3.3	LTC1147-3.3
3A	LT1085-3.3	LTC1148-3.3
5A	LT1084-3.3	LTC1148-3.3
7.5A	LT1083	LTC1148-3.3
10A	LT1087 (X2)	LT1158
15A (20A Peak)	N/A	LT1158



FROM YOUR MIND TO YOUR MARKET  
AND EVERYTHING IN BETWEEN.  
CIRCLE NO. 146



# Solid-state relay saves battery's life

TOM GAY, SIEMENS, REGENSBURG, GERMANY

The circuit in Fig 1 uses a low-resistance p-channel FET,  $Q_4$ , to disconnect a load from the battery when the battery's voltage drops below a certain value. After you disconnect the circuit, it remains off until you remove and replace the battery.

$Q_4$ 's minimum gate-source threshold determines the minimum operating battery voltage of the circuit. For most FETs, this minimum battery voltage is 5V.

The circuit's operating current is low; using the resistor values in Fig 1, the circuit consumes less than 6  $\mu$ A from a 9V battery. The circuit also features a wide input-voltage range, which depends on the maximum collector-emitter voltage rating of the transistors  $Q_1$  through  $Q_3$  and the FET  $Q_4$ .

In operation,  $Q_1$  and  $Q_2$  form a Schmitt trigger that senses the circuit's output voltage. In normal operation,  $Q_1$  is on while  $Q_2$  is off.  $R_5$  and  $R_6$  pull the base of  $Q_3$  high, such that  $Q_4$ 's gate-source voltage across  $R_8$  equals  $-V_{BATT}$ . For battery voltage higher than 10V, select  $R_9$  according to

$$R_9 = R_8(V_{BATT}/V_{GSmax} - 1).$$

However, the circuit does not need  $R_9$  if the battery's voltage is 10V or less.  $D_1$  generates a reference voltage of approximately 1.4V. Because the current through  $D_1$  is low, use the common low-current trick of substituting an LED for a Zener diode. An LED has lower dynamic resistance than a Zener diode does at low currents.

The voltage divider  $R_1$ ,  $R_2$ , and  $R_3$  trim the minimum output voltage at which the Schmitt trigger toggles. When the Schmitt trigger toggles, it turns  $Q_1$  off and  $Q_2$  on. To turn  $Q_3$

on,  $Q_3$ 's base voltage must decrease to a value below the transistor's  $V_{BEmin}$ :

$$V_{BE}(Q_3) = R_7/(R_6 + R_7)(V_{LED} + V_{CEsat}(Q_2)).$$

$Q_3$  turns off, and  $Q_4$ 's gate-source voltage goes to zero.  $Q_4$  disconnects the load. Depleted batteries sometimes recover some of their voltage (but none of their capacity) after disconnection. To avoid reconnection of a depleted battery, the load remains disconnected, even if the input voltage slowly rises again.

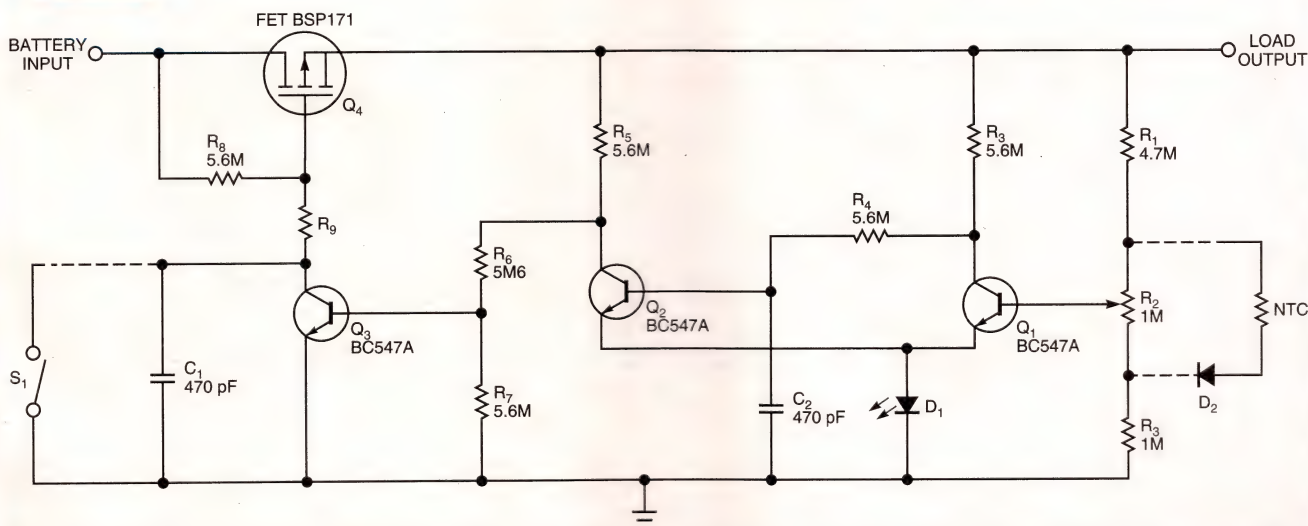
Only inserting a new battery resets the circuit. After you remove the old battery from the circuit, leakage currents discharge capacitors  $C_1$  and  $C_2$  in a couple of seconds. When you insert a new battery, the gate-source capacitance of  $Q_4$  charges with the current flowing into  $C_1$ , connecting the load. For safe turn-on,  $C_1$  must now be less than the gate-source capacitance of  $Q_4$ . Keeping  $C_1$  below three times  $Q_4$ 's gate-source capacitance ensures a reasonable reset time for the circuit.

Replacing potentiometer  $R_2$  with an NTC resistor protects the battery from excessive temperatures. Diode  $D_2$  should be in good thermal contact with transistors  $Q_1$  and  $Q_2$  to reduce the influence of junction temperatures on the turn-off voltage. You could also consider paralleling FETs to increase output-current capability and decrease resistance. The optional switch  $S_1$  resets the circuit to an on state and proves useful if the load experiences a temporary short circuit. (DI #1584)

EDN

To Vote For This Design, Circle No. 390

FIGURE 1



This solid-state relay disconnects a depleted battery and does not reconnect the load until you insert a fresh battery.



# Off-hook phone line supplies 150 mW

RON CLARK AND BOB UNDERWOOD, MAXIM INTEGRATED PRODUCTS, SUNNYVALE, CA

For systems that require 150 mW or less, the power supply in Fig 1 draws power from ordinary phone jacks without interrupting the voice signal, thereby eliminating the need for batteries and ac adapters. Built into peripheral equipment such as PCMCIA modem cards, this circuit can spare the battery in a host computer. The circuit is useful in portable systems that connect to subscriber (household) telephone lines, such as modems and telephone test sets.

The line current available to a telephone in the off-hook state is limited not by regulations or code, but by only the sum of impedances in the central-office battery and intervening phone lines. These line impedances vary greatly in proportion to distance from the central office, so the customary practice of matching impedances for maximum power transfer is impractical.

However,  $D_1$ 's zener-clamp termination works well for line impedances to 1 k $\Omega$  and for worst-case conditions. This termination also meets the one condition imposed on line current by the phone system: Off-hook current must exceed 20 mA to ensure activation of a network-access relay in the central office.

$D_1$  provides approximately 6.8V to the center tap of  $T_1$  and 5V to the  $V_{CC}$  terminal of  $IC_1$ , a 400-kHz oscillator driving an internal flip-flop.  $IC_1$  generates two push-pull, 50%-duty-cycle, 200-kHz square waves that drive internal, ground-referenced switches connected to the primary of  $T_1$ . On the secondary side, Schottky diodes  $D_2$  and  $D_3$  rectify the isolated power, which  $IC_2$ 's low-dropout regulator then regulates to 5V.

$T_1$ 's primary is a center-tapped winding whose ET product (a voltage-time product of 25V  $\mu$ sec) is sufficient to prevent saturation under worst-case conditions. Similarly,  $T_1$ 's turns ratio should provide the minimum required output voltage for maximum load and minimum input voltage. The calculation for the

turns ratio should also assume worst-case losses in  $D_2$  and  $D_3$ .

The resultant turns ratio produces a much higher secondary voltage for best-case conditions, which is acceptable for some applications. If not, you can add a linear regulator ( $IC_2$ ). For isolated 5V outputs, the ideal turns ratio is 1.2CT:1.0CT (CT=Center Tapped). Wind the transformer on Magnetics Inc (Butler, PA, (412) 282-8282) "W," Fair-Rite "76," or other high-permeability magnetic material. To minimize radiated noise, choose a pot core, E/I/U core, toroid, or other geometry with closed magnetic paths.

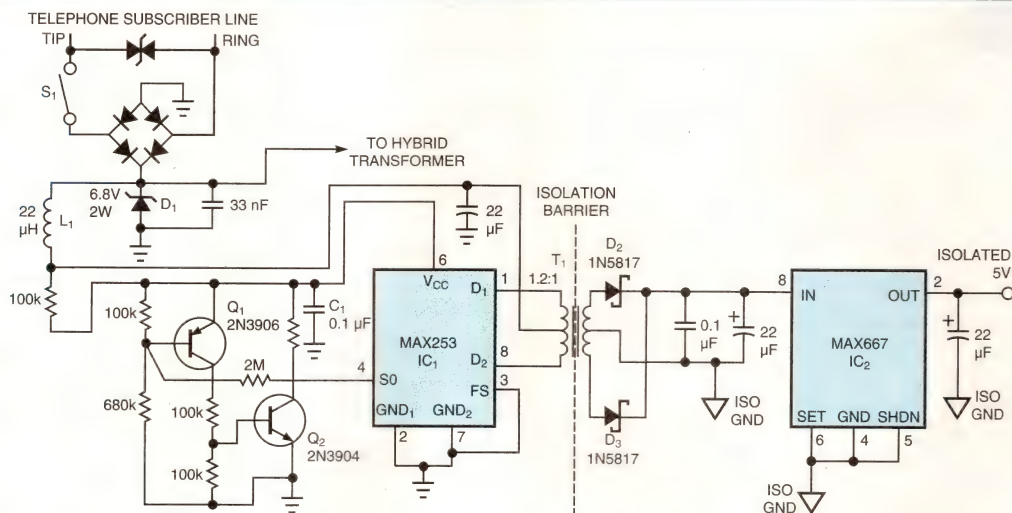
Consider a typical toroid, such as the 40603-TC, which is 0.125 in. thick with a 0.230-in. outside diameter. For 6.8V inputs, this core should have a 48-turn primary (24 turns on either side of the CT), which yields a nominal end-to-end primary inductance of 8 mH. You can scale the secondary for any reasonable output voltage. For example, 40 turns (20 turns on either side of the CT) delivers 5.2V min, as required by the linear regulator for maintaining a regulated 5V output.

For isolated 3.3V applications, the minimum voltage to  $IC_2$  is 3.5V.  $T_1$ 's turns ratio should be 2.0CT:1.0CT, with a primary ET product of at least 25V  $\mu$ sec. If you use the same 48-turn primary as for 5V applications, the required number of secondary turns is 24 (12 on either side of the CT). In addition, you must add a resistive divider for setting  $IC_2$ 's regulated output to 3.3V.

$Q_1$ ,  $Q_2$ , and the associated resistors ensure a low-power shutdown mode for  $IC_1$  until its supply voltage can sustain a full power-up.  $IC_1$ 's supply current is fairly constant, so light filtering (by  $L_1$  and  $C_3$ ) is sufficient to prevent noise from entering the hybrid transformer (not shown). (DI #1573) EDN

To Vote For This Design, Circle No. 391

FIGURE 1



NOTES:  $S_1$  IS NORMALLY OPEN.  
CLOSED INDICATES THE OFF-HOOK CONDITION.

This circuit draws current in the off-hook condition, delivering as much as 150 mW of isolated power while allowing normal voice or data communications over the phone line.



# Seeing is believing



## Multi Media System Solution for Image Capture and Displaying

SHARP has the right solution for your application, whether you need a CCD camera in PAL or NTSC norm, with electronic or mechanical iris, with composite or YUV output or if you need the colour display in the range from 3" to 14.2" in TFT or passive technology with analogue or digital interface.

SHARP ELECTRONICS (EUROPE) GMBH  
Microelectronic Division (MED)  
SonninstraÙe 3, 20097 Hamburg  
Phone +49-40/2376-2286, Telex 2 161 867  
Telefax +49-40/2376 22 32

SHARP ELECTRONICS (EUROPE) GMBH  
Liaison Offices in  
Paris · Milano · Stuttgart · Nürnberg · London · Dublin

# SHARP

THE IDEAS COMPANY

CIRCLE NO. 37



# Cúk converter yields 90% efficiency

PETER DEMCHENKO, VN, VILNIUS, LITHUANIA

The simple dc/dc converter in Fig 1 has an efficiency of 90% min and output ripple measured at 10 mV p-p.

This circuit employs an inexpensive 78L15 regulator in an unusual manner. The regulator, IC<sub>2</sub>, operates as a voltage-level shifter. Because the regulator's normal output is tied to ground, the regulator tries to maintain its input at its characteristic 15V above its voltage-reference (V<sub>R</sub>) pin's level by drawing the appropriate current through biasing resistor R<sub>1</sub>. You can use this trick with any member of the 78LXX family.

The regulator is part of a feedback loop that controls the circuit's pulse-width modulator. The pulse-width modulator comprises Q<sub>1</sub>, gate IC<sub>1B</sub>, and associated components. The Cúk configuration of the output stage, comprising Q<sub>2</sub>, Q<sub>3</sub>, and the transformer, has inherently low input and output ripple.

Oscillator IC<sub>1A</sub> and associated components, which feed the

pulse-width modulator, operate at a fixed frequency of 350 kHz, simplifying output-noise filtering. Because of this relatively high frequency, use low-ESR, tantalum-chip capacitors instead of electrolytic capacitors. Similarly, use a fast epitaxial diode for D<sub>1</sub>.

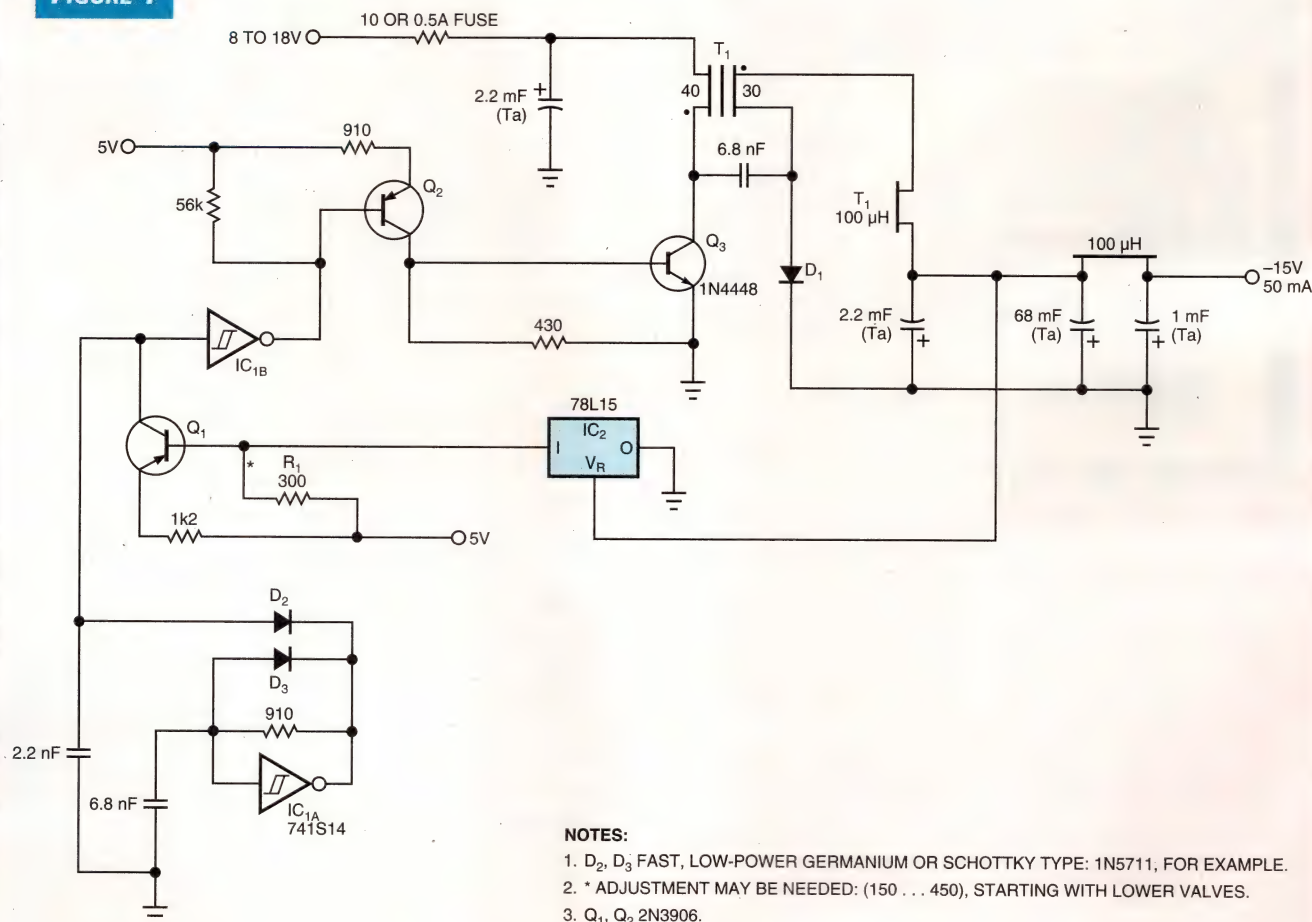
A 74HC14 is preferable for IC<sub>1</sub>, but the brave old 74LS14 works (component values shown are for the LS version). Select a fast switching transistor for Q<sub>3</sub>, which can sustain I<sub>C</sub>>1A, V<sub>CE</sub>>60V.

Transformer T1 is a toroid, 11 mm in diameter having 0.3-mm enameled wire for the primary and secondary windings. Your circuit's layout must be as compact as possible, having no long runs. (DI #1579)

EDN

To Vote For This Design, Circle No. 392

FIGURE 1



This switching dc/dc converter presses an inexpensive linear voltage regulator into service as a voltage-level shifter.



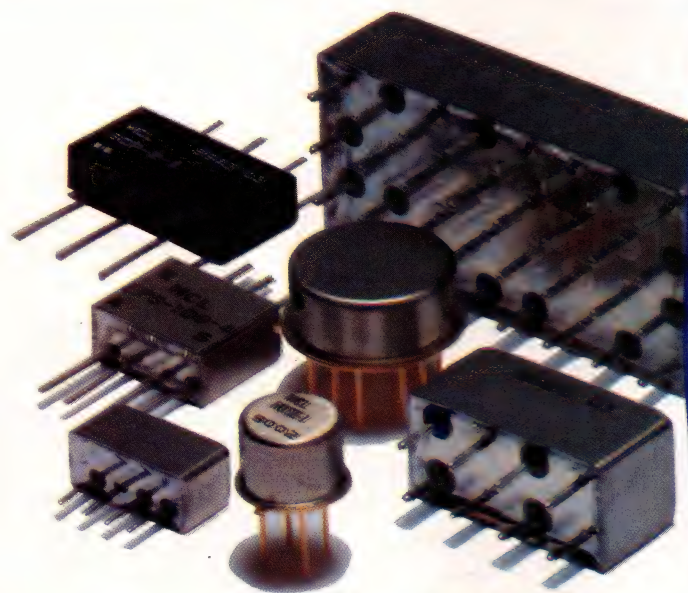
# POWER SPLITTERS/ COMBINERS

the world's largest selection  
2KHz to 10GHz from \$2<sup>95</sup>


With over 300 standard models, from 2-way to 48-way, 0°, 90° and 180°, 50- and 75-ohms, covering 2KHz to 10GHz, Mini-Circuits offers the world's largest selection of off-the-shelf power splitter/combiners. And, with rapid turnaround time, we'll also supply "special" needs, such as wider bandwidth, higher isolation, lower insertion loss and phase matched ports.

Available for use in military and commercial requirements, models include plug-in, flat-pack, surface-mount, connectorized standard and custom designs. New ultra-miniature surface mount units provide excellent solutions in cellular communications, GPS receivers, Satcom receivers, wireless communications, and cable systems.

All units come with a one-year guarantee and unprecedented "skinny" sigma unit-to-unit and production run-to-production run repeatability. All catalog models guaranteed to ship in one week. Mini-Circuits...dedicated to exceed our customers' expectations.



finding new ways...  
setting higher standards

 **Mini-Circuits®**

P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661

For detailed specs on all Mini-Circuits products refer to • THOMAS REGISTER • MICROWAVE PRODUCT DATA DIRECTORY • EEM • MINI-CIRCUITS' 740- pg. HANDBOOK.

*CUSTOM PRODUCT NEEDS...Let Our Experience Work For You.*



# Two LEDs perform rudimentary spectral analysis

PETER BOJLOV, ISOMATIK SORTEX LTD, PAZARDJIK, BULGARIA

A pair of LEDs having different wavelengths can supply the stimulus for a rudimentary spectral analysis during quality-control sorting operations. By measuring the reflectance of each LED, the circuit in Fig 1 can provide information about the spectral response of the object under test. The circuit's operation is akin to the human eye's using three receptors to deduce information about the entire visible spectrum.

The circuit in Fig 1 has two emitters,  $D_1$  and  $D_2$ , but only one sensor, a TI TSL250 integrated photo receiver,  $IC_1$ . The clock circuit,  $IC_2$ ,  $IC_3$ , and associated components multiplex the single sensor between the two LEDs' outputs, as well as sampling the ambient light.

$IC_3$ 's  $Q_1$  and  $Q_6$  outputs turn on an LED and its corre-

sponding S/H amplifier via the NAND-gate chains. The delay networks at the inputs of the NAND-gate chains going to the sensor's S/H ICs compensate for the sensor's output-response delay.

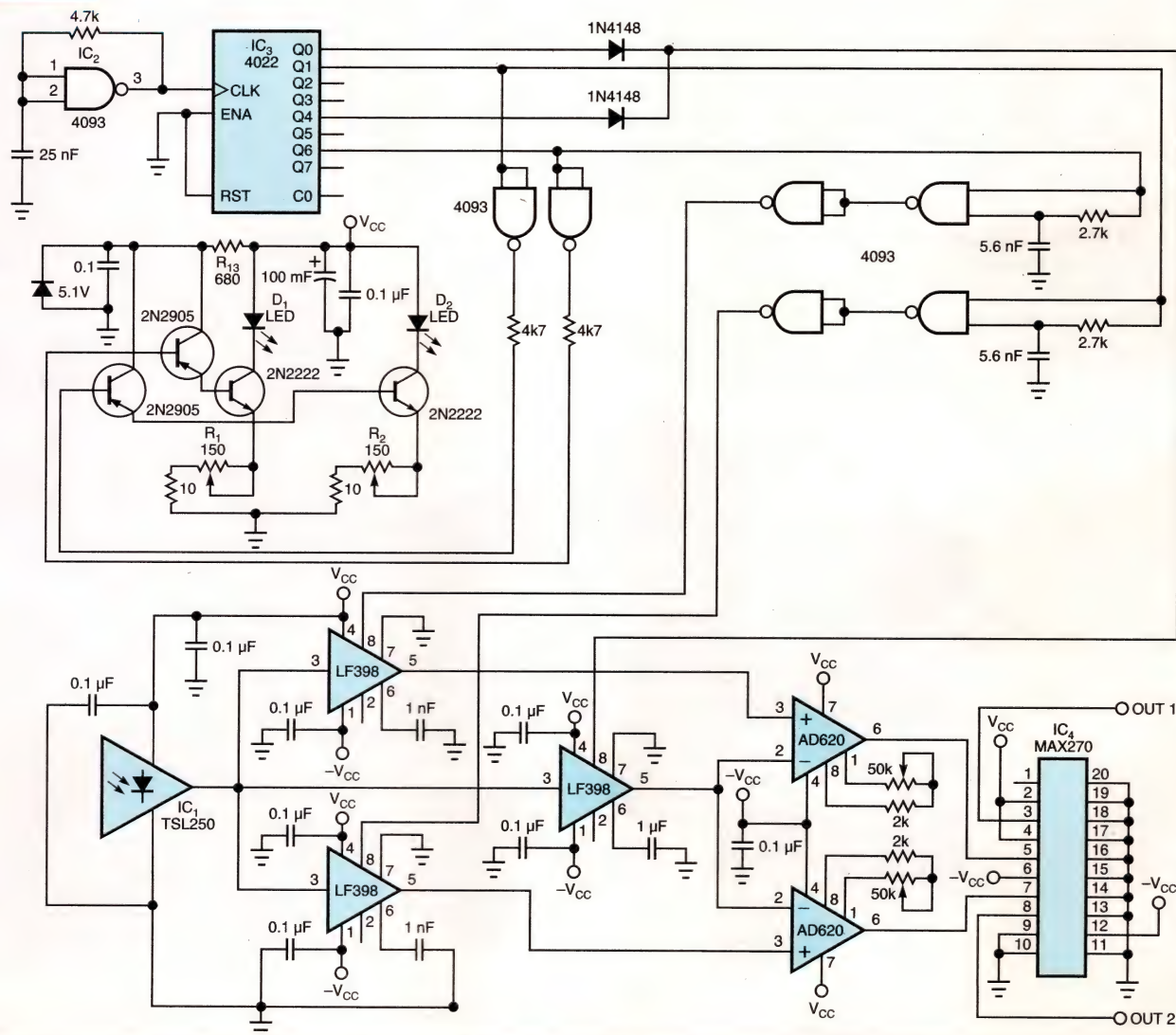
$IC_3$ 's  $Q_4$  and  $Q_0$  outputs, diode-ORed together, take a sample of the ambient light when the LEDs are off. The circuit subtracts this reading from the LEDs' readings. The MAX 720 programmable filter,  $IC_4$ , cleans up the outputs of two LEDs' reading.

Potentiometers  $R_1$  and  $R_2$  allow you to adjust the LEDs' current between 25 and 400 mA. (DI #1580)

EDN

To Vote For This Design, Circle No. 393

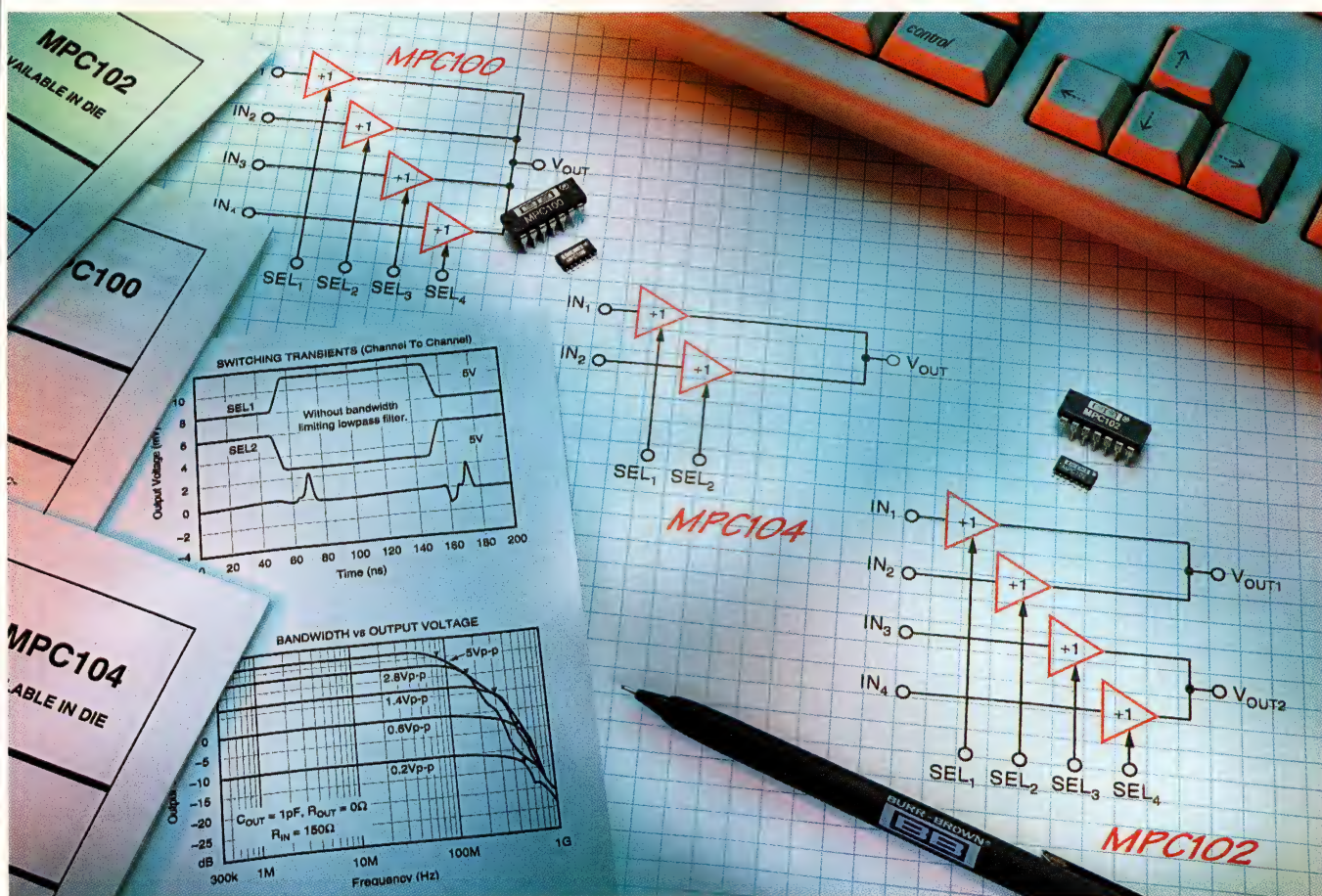
FIGURE 1



Illuminating an object under test by two LEDs having different wavelengths allows you to perform a rudimentary spectral analysis of the object. You can use this simple scheme to sort fruits and vegetables automatically, for example.



# Simple Signal Switching Solutions



## Wideband Buffered Multiplexer Family

**MPC100, MPC102, and MPC104** are high speed, video multiplexers that make it easy to route and distribute wideband analog and digital signals. Their unique complementary bipolar design delivers high speed processing with low transients while switching. All achieve excellent levels of interchannel crosstalk and harmonic distortion. These new multiplexers are your simple solutions for HDTV, RF, video, radar, computer graphics distribution, and data acquisition applications.

## Minimizes Crosstalk, Distortion, and Cost

This new family not only minimizes crosstalk and distortion, but also minimizes your design costs. You pick the multiplexer that fits your design best.

- **MPC100** is a 4-to-1 wideband video multiplexer for large crosspoint fields.
- **MPC102** is a versatile, dual 2-to-1 multiplexer. Use it as a 1-to-2 demultiplexer or a 2-to-1 multiplexer for differential/analog ECL signals.
- **MPC104** is a single 2-to-1 high speed multiplexer with a small signal bandwidth of 590MHz.

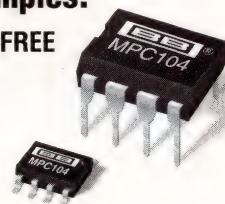
## MPC Family Key Specifications

- Wide bandwidth .....210MHz (1.4Vp-p)
- Low crosstalk .....-70dB (30MHz)
- Low distortion .....-64dBc
- Low switching transients .....+6/-8mV
- Low quiescent current.....4.6mA (one channel selected)
- Low differential gain/phase errors .....0.02%, 0.02°
- Packages

<b>MPC100</b> .....	14-pin DIP, SO
<b>MPC102</b> .....	14-pin DIP, SO
<b>MPC104</b> .....	8-pin DIP, SO

## Switch One On...FREE Samples!

Switch your own signals—to get your **FREE** sample and detailed data sheets, just FAX **1-602-741-3895**. Or, contact your local sales rep for more information.



CIRCLE NO. 137



International Subsidiary Offices: Austria (43) 1 602 63 71, France (33) 1 395 43558, Germany (49) 711 77040, Italy (39) 2 580 10504, Japan (81) 33 586 8141, Netherlands (31) 3465 50204, Switzerland (41) 1 7240928, United Kingdom (44) 923 233837.

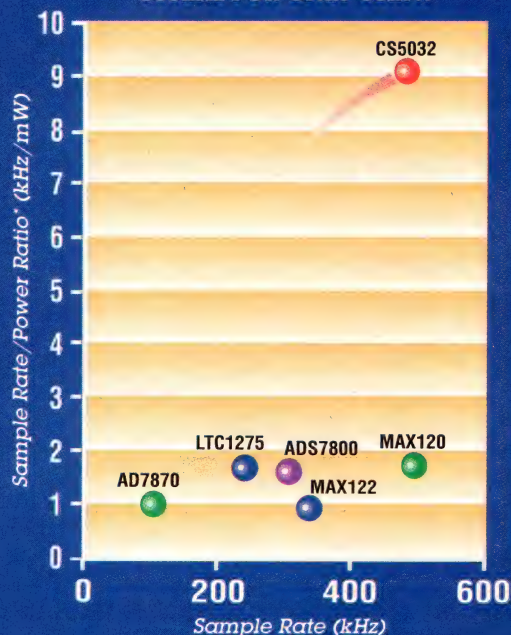


The next 12-bit ADC  
standard drives speed/power  
performance to new heights.



IT'S ACCURATE.  
IT'S CRYSTAL.

THE CS5032 DELIVERS  
500kHz FOR ONLY 55mW



\*Datasheet specifications for -55 C/125 C

**CRYSTAL**  
SEMICONDUCTOR CORPORATION

U.K. +44 (0) 27 641 8201  
Germany +49 (0) 815 240 088

CIRCLE NO. 74

## Design Entry Blank

**\$100 Cash Award** for all published entries selected by editors. An additional **\$100 Cash Award** for the winning design of each issue, determined by vote of readers. Additional **\$1500 Cash Award** for annual Grand Prize Design, selected among biweekly winners by vote of editors.

To: Design Ideas Editor, EDN Magazine  
Cahners Publishing Co  
275 Washington St, Newton, MA 02158

I hereby submit my Design Ideas entry.

Name \_\_\_\_\_

Title \_\_\_\_\_ Phone \_\_\_\_\_

Company \_\_\_\_\_

Division (if any) \_\_\_\_\_

Street \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_

Country \_\_\_\_\_ Zip \_\_\_\_\_

Design Title \_\_\_\_\_

Home Address \_\_\_\_\_

Social Security Number \_\_\_\_\_  
(US authors only)

### Entry blank must accompany all entries.

Design entered must be submitted exclusively to EDN, must not be patented, and must have no patent pending. Design must be original with author(s), must not have been previously published (limited-distribution house organs excepted), and must have been constructed and tested. Fully annotate all circuit diagrams. Please submit software listings and all other computer-readable documentation on a IBM PC disk in plain ASCII.

Exclusive publishing rights remain with Cahners Publishing Co unless entry is returned to author, or editor gives written permission for publication elsewhere.

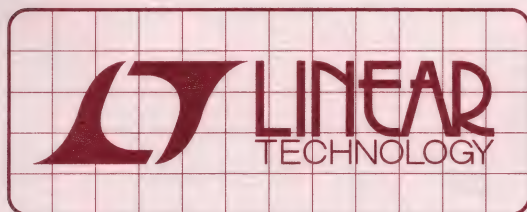
In submitting my entry, I agree to abide by the rules of the Design Ideas Program.

Signed \_\_\_\_\_

Date \_\_\_\_\_

**Your vote determines this issue's winner.** All designs published win \$100 cash. All issue winners receive an additional \$100 and become eligible for the annual \$1500 Grand Prize. **Vote now** by circling the appropriate number on the reader inquiry card.





# DESIGN NOTES

## Ultra-Low Power, High Efficiency DC/DC Converter Operates Outside the Audio Band – Design Note 86

Mitchell Lee

Portable communications products are densely packed with signal processing, microprocessor, radio frequency, and audio circuits. Digital clock noise must be eliminated not only from the audio sections, but also from the antenna which, by the very nature of the product, is located only inches from active circuitry. If a switching regulator is used in the power supply, it becomes another source of noise. The LTC1174 step-down converter is designed specifically to eliminate noise at audio frequencies while maintaining high efficiency at low output currents.

Figure 1 shows an all surface mount solution for a 5V, 120mA output derived from 5 to 7 NiCd or NiMH cells. Small input and output capacitors that are capable of handling the necessary ripple currents help conserve space. In applications where shutdown is desired this feature is available (otherwise short this pin to  $V_{IN}$ ).

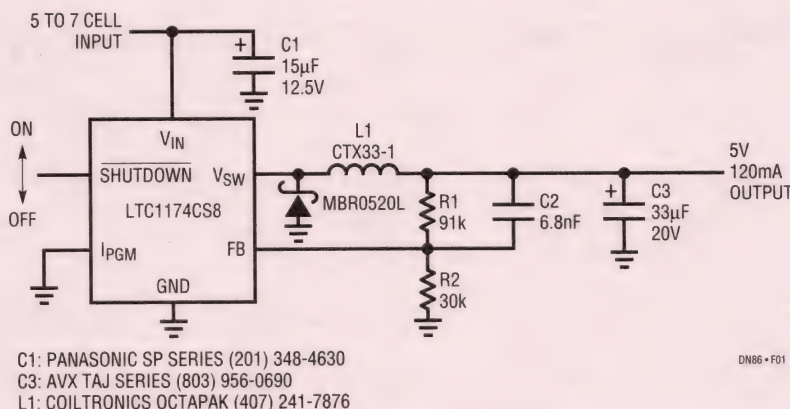
The LTC1174's internal switch, connected between  $V_{IN}$  and  $V_{SW}$ , is current controlled at a peak of approximately 340mA. Low peak switch current is one of the key features that allows the LTC1174 to minimize system noise compared to other chips which carry significantly higher peak

currents, easing shielding and filtering requirements and decreasing component stresses. Output currents of up to 450mA are possible with this device by connecting the  $I_{PGM}$  pin to  $V_{IN}$ . This increases the peak current to 600mA, allowing for a high average output current.

To conserve power and maintain high efficiency at light loads, the LTC1174 uses Burst Mode™ operation. Unfortunately, this control scheme can also generate audio frequency noise at both light and heavy loads. In addition to electrical noise, acoustical noise can emanate from capacitors and coils under these conditions. A feed-forward capacitor (C3) shifts the noise spectrum up and out of the audio band, eliminating these problems. C3 also reduces peak-to-peak output ripple to approximately 30mV over the entire load range.

A toroidal surface mount inductor (L1) is chosen for its excellent self-shielding properties. Open magnetic structures such as drum and rod cores are to be avoided since they inject high flux levels into their surroundings. This can become a major source of noise in any converter circuit.

Burst Mode is a trademark of Linear Technology Corporation



**Figure 1. Low Noise, High Efficiency Step-Down Regulator  
for Personal Communications Devices**



The interactions of load current, efficiency, and operating frequency are shown in Figure 2. High efficiency is maintained at even low current levels, dropping below 70% at around 800 $\mu$ A. No load supply current is less than 200 $\mu$ A, dropping to approximately 1 $\mu$ A in shutdown. The operating frequency rises above the telephony bandwidth of 3kHz at a load of 1.2mA. Most products draw milliampere range load currents only in standby with the audio circuits squelched, when low frequency noise is not an issue.

The frequency curve depicted in Figure 2 was measured with a spectrum analyzer, not a counter. This ensures that the lowest frequency noise peak is observed rather than a faster switching frequency component. Any tendency to generate subharmonic noise is quickly exposed using this measurement method.

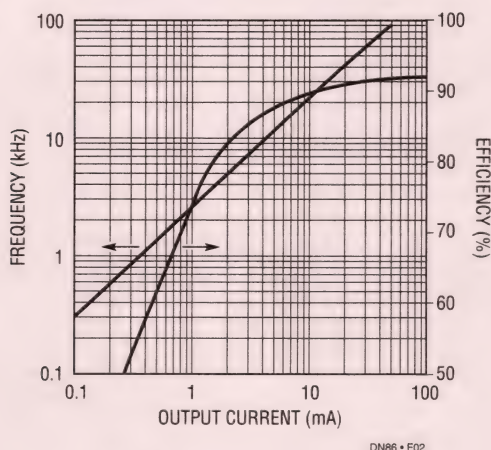


Figure 2. Parameter Interaction

A spectrum analysis of noise from 100kHz to 10MHz is shown in Figure 3. The fundamental switching component in this test was approximately 85kHz, and the second harmonic shows up at twice that frequency. It measures approximately 3mV<sub>RMS</sub>. Harmonics of the 85kHz funda-

mental disappear into a 10 $\mu$ V "mud" between 1MHz and 2MHz. Noise in the critical 455kHz region ranges from 10 $\mu$ V to 300 $\mu$ V, depending on operating frequency. At 10.7MHz, an important and sensitive intermediate frequency, the noise is broadband and well below 10 $\mu$ V<sub>RMS</sub>.

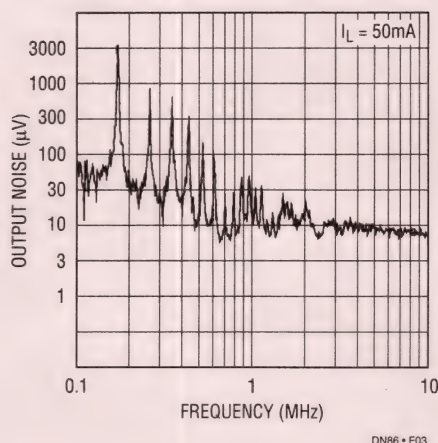
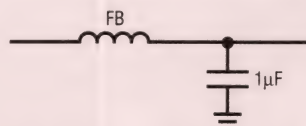


Figure 3. Noise in the 100kHz to 10MHz Band

Further noise reduction is possible by adding an output filter (see Figure 4). A small surface mount ferrite bead is placed in series with the 5V output, close to the LTC1174 and bypassed by a 1 $\mu$ F surface mount ceramic capacitor. Noise attenuation at 10MHz exceeds 20dB.



FB: DALE ILB-1206 31 25% (605) 665-9301  
1 $\mu$ F: AVX 12063G105ZAT (803) 448-9411

DN86 • F04

Figure 4. An Effective Filter for Attenuating Noise Components Above 1MHz

For literature on our DC/DC Converters, call **1-800-4-LINEAR**. For applications help, call (408) 432-1900, Ext. 361



# FAST FASTER FASTTEST

## High Speed Audio Frequency Testing



### Audio Precision offers a Full Range of Audio Test Sets...

#### FAST

**ATS-1** is a competitively priced audio test set featuring front panel and GPIB programmable operation as well as higher performance and speed than the typical audio testers it replaces. Both Audio Precision and HP 8903B GPIB command sets are supported. A sample suite of 43 measurements<sup>1</sup> takes only 33 seconds. The dual channel ATS-1 is at home in production floor environments thanks to its rugged fan-cooled enclosure and front or rear mount modular connector panels.

#### FASTER

**System One** automated integrated audio test sets measure distortion, frequency, phase, wideband or selective noise, and crosstalk in production test environments benefiting from high speed and performance. System One can make a sample suite of 43 measurements<sup>1</sup> in 21 seconds. Optional spectrum analysis and digital domain signal generation and analysis capabilities make it the one-stop audio test system. Available both in GPIB and PC controlled versions, System One is today's recognized standard in audio testing.

#### FASTTEST

**System One DSP** versions test any audio channel in the *fastest* possible time. With DSP power, **FASTTEST** completes the 43 measurement<sup>2</sup> example above in 2 seconds! System One **FASTTEST** technology generates and analyzes special multi-sinewave test signals. These wideband signals provide complete frequency response, distortion and noise measurements from a single stimulus acquisition.

**Audio  
precision**

P.O. Box 2209  
Beaverton, OR 97075-3070  
(503) 627-0832 (800) 231-7350  
FAX: (503) 641-8906

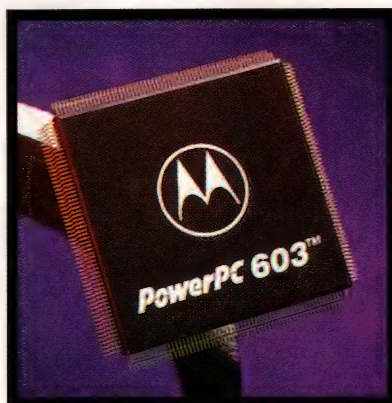
<sup>1</sup>Sample suite of GPIB programmed audio measurements included 1) noise measurement (20Hz-22kHz bandpass).

2) 31 point single tone frequency response sweep over 20Hz-22kHz range, and 3) 11 point distortion sweep over 20Hz-22kHz range.

<sup>3</sup>FASTTEST uses multi-tone stimulus and analysis to make the same measurements listed above.

INTERNATIONAL DISTRIBUTORS: **Australia:** IRT Electronics Pty. Ltd., Tel: 2 439 3744 **Austria:** ELSINCO GmbH, Tel: (222) 815 04 00 **Belgium:** Trans European Music NV, Tel: 2/466 5010 **Brazil:** INTERWAVE LTDA, Tel: (21) 325-9221 **Bulgaria:** ELSINCO h.e. Strelbishte, Tel: 92 581 698 **Canada:** GERRAUDIO Distribution, Tel: (416) 696-2779 **China, Hong Kong:** A C E (Int'l) Co. Ltd., Tel: 424-0387 **Czech Republic:** ELSINCO Praha spol. s r.o., Tel: (2) 4702 1 451, 452 **Denmark:** npn Elektronik a/s, Tel: 86 57 15 11 **Finland:** Genelec OY, Tel: 77 13311 **France:** ETS Mesureur, Tel: (1) 45 83 66 41 **Germany:** RTW GmbH, Tel: 221 70913-0 **Greece:** KEM Electronics O.E., Tel: 01-6478514/5 **Hungary:** ELSINCO KFT, Tel: (1) 112 4854 **India:** HINDITRON Services PVTY, Tel: 22 836-4560 **Israel:** Dan-El Technologies, Ltd., Tel: 3-544-1466 **Italy:** Audio Link s.n.c., Tel: 0521/648723 **Japan:** TOYO Corporation, Tel: 3 (5688) 6800 **Korea:** B&P International Co., Ltd., Tel: 2 546 1457 **Malaysia:** Test Measurement & Engineering Sdn. Bhd., Tel: 3 734 1017 **Netherlands:** TM Audio B.V., Tel: (0) 30 414070 **New Zealand:** Audio & Video Wholesalers, Tel: 7 847-3414 **Norway:** Lydconsult, Tel: 9 19 03 81 **Poland:** ELSINCO Polska sp. z o.o., Tel: (22) 39 69 79 **Portugal:** Acutron Electroacustica LDA, Tel: 1 9414087 / 9420862 **Singapore:** TME Systems Pte Ltd., Tel: 298-2608 **Slovakia:** ELSINCO Bratislava spol. s r.o., Tel: (7) 784 165 **South Africa:** SOUND FUSION, Tel: 11 477-1315 **Spain:** Telco Electronics, S. A., Tel: 1 531-7101 **Sweden:** Tal & Ton Elektronik AB, Tel: 31 80 36 20 **Switzerland:** Dr. W.A. Gunther AG, Tel: 1 910 41 41 **Taiwan:** ACESONIC Int'l Co., Ltd., Tel: 2 719 2388 **United Kingdom:** SSE Marketing Ltd., Tel: 71 387-1262





*If* our FastScan ATPG can handle a chip like this, just imagine what it will do for your ASIC or IC.

Like every other product manufactured by Motorola, the PowerPC 603™ family of microprocessors is subject to the company's rigorous Six Sigma quality program.

So, not surprisingly, testability was a major issue with the PowerPC 603 family. Nothing but the best would do.

No small task in a chip with over 1.6 million transistors. How do you get maximum fault coverage to ensure quality, yet minimize your test vectors to boost productivity?

Simple. You turn to Mentor Graphics' FastScan™ ATPG, the test pattern generation tool now used by IC and ASIC developers throughout the world. In the PowerPC 603, FastScan not only produced maximum fault coverage with minimum vectors, it did so within an extremely tight design schedule.

In fact, it performed so well, Motorola has selected it as the ATPG tool of choice for the entire PowerPC 603 family project.

Better yet, FastScan is just one of our standard-setting tools that deliver a full-chip test solution for virtually any IC or ASIC, large or small.

Everything from boundary scan insertion at the VHDL level to full ATPG for non-, partial-, and full-scan designs to exhaustive fault coverage analysis.

So put us to the test, the way the PowerPC 603 microprocessor did. Phone 1-800-547-3000, dept. 327 for more information on Mentor Graphics' Full-Chip Test. Or E-mail us at: [dft\\_mgc@mentorg.com](mailto:dft_mgc@mentorg.com).



We mean business.

PowerPC 603 and the PowerPC name and the PowerPC logotype are trademarks of International Business Machines Corporation, used under license therefrom.



# Charge batteries safely in 15 minutes by detecting voltage inflection points

GARY CUMMINGS, SPECTRA RESEARCH, DANIEL BROTT, BLACK AND DECKER CORP,  
AND JAMES GOODHART, ZILOG INC

Consumer demands for portability and convenience create new opportunities for manufacturers of electrical and electronic equipment. As NiCd (nickel-cadmium) and NiMH (nickel-metal-hydride) batteries offer increased capacity and improved durability, rechargeable-battery operation becomes increasingly common. But greater use of battery power challenges product-design engineers: Prolonged recharging times and the need to replace worn-out batteries annoy and inconvenience users. For fast, high-current chargers, conventional control methods often are ineffective, causing gradual battery deterioration—or worse. Furthermore, recent innovations that extend battery life while permitting recharging in 15 minutes or less complicate charger design.

New battery types, including NiMH, lithium-ion, and others, offer better performance than NiCd but at a higher cost. Many conventional intelligent battery chargers utilize  $dV/dt$  (slope) detection, which senses changes in voltage exhibited by most batteries in the early stages of overcharge (Fig 1). NiCd battery voltage exhibits a characteristic 30- to 50-mV decline after full charge. "Minus-delta-voltage" sensing detects this change, but only after some degree of overcharging. NiCd batteries tolerate some amount of overcharging, especially at low charge currents, but overcharging causes the batteries to deteriorate and gradually lose storage capacity.

When overcharged, NiMH batteries show a decline of just 3 to 5 mV, which is difficult to detect using minus-delta-voltage methods. Recently offered charging controllers for NiMH batteries generally abandon the minus-delta-voltage charging-termination technique in favor of zero-slope detection, which senses a characteristic leveling off of NiMH battery voltage after full charge (Fig 2). Because of the subtle

Modern, battery-powered electronic products require rapid charging of NiCd, NiMH, and other types of batteries. But if a fast charger doesn't know when to stop, it can easily cause damage. Conventional means of sensing full charge terminate charging too late. Here's a technique that stops the charging in time.

nature of the NiMH  $dV/dt$  characteristic, this method compromises the accuracy of full-charge detection to achieve noise immunity. Unfortunately, NiMH batteries are intolerant of overcharging, which can be especially troublesome at charge rates of 1C or greater. (C refers to a current numerically equal to a battery's ampere-hour (Ahr) capacity.)

High charge currents demand accurate full-charge detection. This article describes and details the cost and performance advantages of an accurate, low-cost, fast-charging control method based on detecting battery-voltage inflection points. The technique works with NiCd, NiMH, and other battery types.

## The design task

Fast battery chargers consist of two sections: a power converter, generally configured as a constant-current source, and a charging controller, which enables and disables the power supply in response to selected battery state-of-charge indicators. These indicators are time-variant physical parameters that change predictably through the battery-charging process. Several indicators are possible, including battery voltage, temperature, pressure, and, in the unusual case of constant-voltage charging, battery current. Most conventional chargers monitor battery voltage and/or temperature and analyze them either individually or in combination. The controller generally considers both absolute thresholds and the monitored quantities' rate of change with time. The suitability of a given control method depends on the type of battery and the accuracy needed for full-charge detection. The required accuracy of full-charge detection is a function of the charging-current magnitude.

In a trickle charger, full-charge detection can be approximate. In fact, a low-current charger can charge batteries con-



## FAST BATTERY CHARGERS

tinuously until you remove them (Fig 3). In this case, the battery's temperature and pressure are elevated above normal but will stabilize within the battery's design limits, causing little or no damage. High charging currents, on the other hand, require accurate full-charge detection. Fast chargers can quickly cause battery damage if they continue to apply high current after full charge.

Fast battery charging requires high charging currents. To achieve full charge in 20 minutes, a fully discharged notebook-computer battery pack with 2.2 Ahr capacity requires a 3C charging rate (or 6.6A average). At this charging current, accurate sensing of a full-charge condition is essential to prevent overcharging from causing battery damage. In Fig 4, notice that the battery's internal temperature and pressure increase dramatically if high current continues after the battery reaches full charge. For NiCd batteries, repeated or prolonged temperature excursions over 40°C cause gradual loss of the battery's storage capacity. The product's user bears the hidden cost of premature battery replacement. The rate of deterioration depends on the degree of overcharge and the resultant heating. NiMH batteries are more sensitive than NiCd in this respect; a single overcharging event can cause serious battery damage.

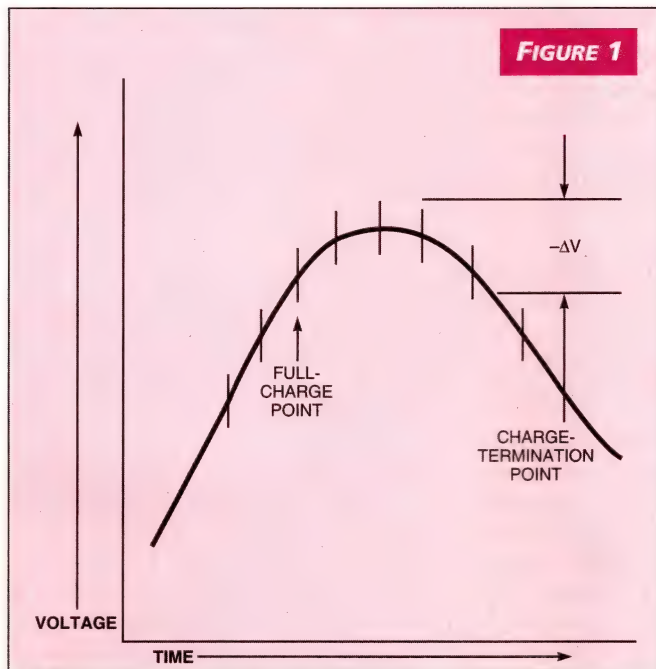
Conventional methods of terminating fast charge, which include detection of zero or minus-dV/dt battery-voltage slope and the rate of battery-temperature change, dT/dt, rely on indicators that become evident only after the battery is fully charged. These schemes cause repeated overcharging because the battery is already past full charge when typical charge-termination points are reached.

Responding to the need to terminate charging before bat-

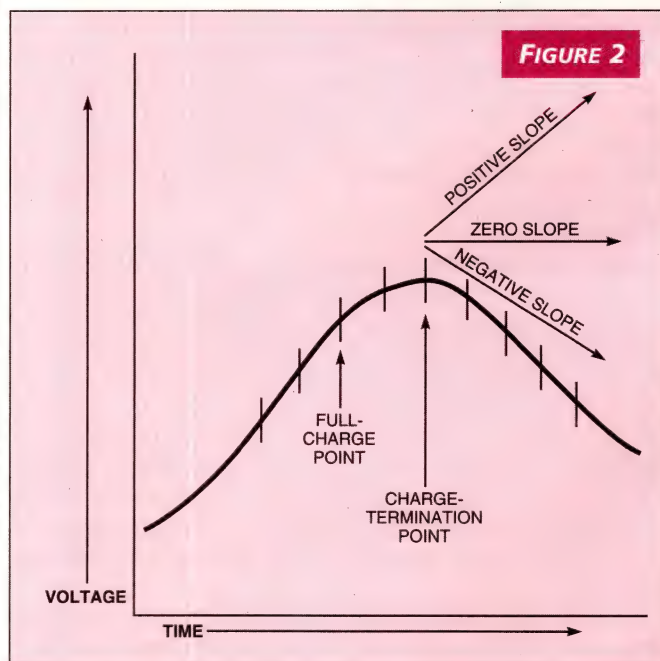
tery damage occurs, the engineers at Black and Decker developed a combination of proprietary techniques. Using microcontrollers, the Black and Decker engineers designed a series of cost-effective, "smart" battery chargers that enable power-tool users to charge NiCd battery packs in as little as 15 minutes. Years of development and production have refined the production methods. Zilog has licensed these patented techniques for use by purchasers of its microcontrollers. Particular features of Zilog's Z8 architecture, such as the onboard analog comparators, make Z8-based smart-charger designs especially cost-effective.

The primary innovation of the Z8-based smart charger relies on analysis of the battery's voltage characteristic with respect to time. The Black and Decker engineers noted that the battery's dV/dt exhibited predictable, characteristic changes during charging (Fig 5). When a fully discharged battery recharges rapidly, there is a brief, sharp battery-voltage increase followed by an extended time interval during which dV/dt is very low. For NiCd batteries, terminating charging during this interval replenishes 70 to 80% of the stored energy. Continued charging causes a distinctly noticeable increase in dV/dt. As battery charge approaches capacity, dV/dt begins to decrease; beyond full charge, the dV/dt goes negative. By the time this occurs, the battery temperature and pressure have begun to increase rapidly because additional energy supplied to the battery cannot be converted to electrochemical potential.

Black and Decker calls the improved technique inflection analysis. An inflection is any point in the battery's charging cycle at which the second derivative of battery voltage with respect to time ( $d^2V/dt^2$ ) changes polarity (Fig 5, points A and B). The Black and Decker technique accurately detects inflec-



If you continue to charge a NiCd battery after it reaches full charge, its terminal voltage actually declines. Some chargers detect this negative voltage change and use it to terminate charging. Chargers based on this phenomenon can't stop the charging until after the battery reaches full charge.



A better charge-termination scheme senses the rate of change (slope) of the battery's terminal voltage vs. time. When the slope changes from positive to negative or zero, charging stops. But charging still continues past full charge.



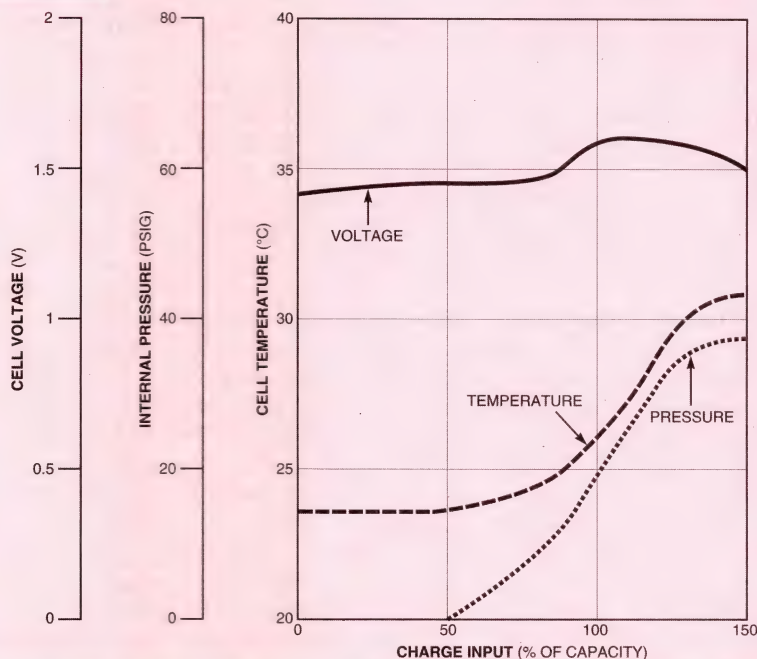
tions in the battery voltage as charging occurs. In particular, this method accurately detects and terminates charging at the "full-charge" inflection point at which  $dV/dt$  begins to decrease. Conventional slope-detection methods wait for zero or negative  $dV/dt$ , but by then the battery is in overcharge. This difference becomes particularly important when charging NiMH batteries.

Inflection analysis requires periodic sampling of the battery voltage. The Z8 smart-charging controller maintains a buffer that contains recent battery-voltage A/D readings. At each sampling interval, the Z8 calculates a new value of  $dV/dt$  and compares the result with previous values. To achieve repeatable results, A/D readings are taken with charging current turned off to minimize unpredictable IR drops. (The combination of dirty contacts and high charging currents causes unpredictable variations in battery-voltage readings, especially in the presence of shock or vibration.) Storing the A/D readings and using digital-processing methods further improves noise immunity. Should special system considerations exist, the software-based inflection-analysis technique is easily adjustable.

### Log A/D conversion

A second patented Black and Decker innovation is a simple, cost-effective A/D technique that measures battery voltage. Since inflection analysis determines charge level by comparing slope values, it can use relative-voltage A/D readings instead of costly absolute A/D voltage methods. The patented A/D method uses Zilog's Z8 with onboard analog comparators and a small number of external components for A/D measurements (Fig 6). A resistive divider attenuates the battery voltage to within the Z8 comparator's common-mode input-voltage range. A resistor and capacitor generate a logarithmic reference voltage that is applied to the inverting input of the Z8's internal voltage comparator. A Z8 port pin either charges the capacitor in preparation for A/D measurement or discharges the capacitor during A/D conversion. An internal counter is initialized. The Z8 then starts the counter while

FIGURE 3



**In a trickle charger, full-charge detection can be approximate. In fact, a low-current charger can charge batteries continuously until they are removed. In this case, the battery temperature and pressure are elevated above normal but will stabilize within the battery's design limits, causing little or no damage.**

FAST CHARGING (1 TO 4C RATES)  
REQUIRES HIGH CHARGING CURRENT

OUR CHARGING METHOD  
TERMINATES HERE

TYPICAL VOLTAGE  
SENSING METHOD  
TERMINATES HERE

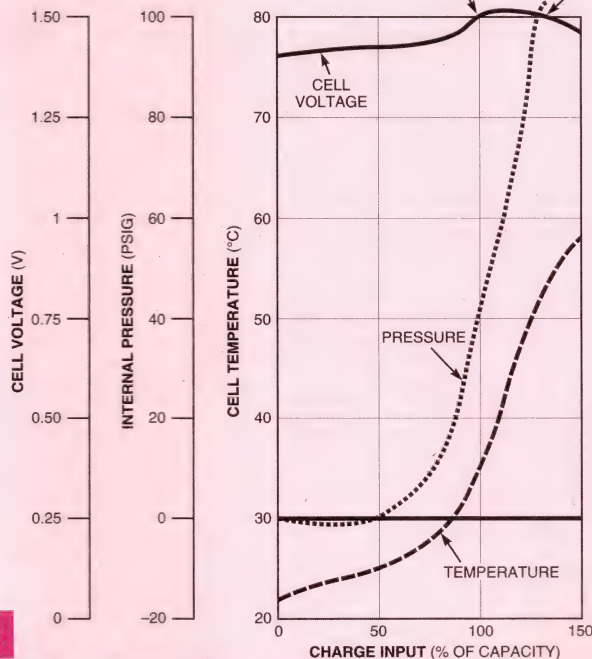


FIGURE 4

**With fast charging, the battery's internal temperature and pressure increase dramatically if the high current continues after the battery reaches full charge.**



## FAST BATTERY CHARGERS

simultaneously commanding the external R-C network to start generating a falling logarithmic reference voltage for the comparator. When the falling R-C voltage crosses the scaled battery-voltage level at the other comparator input, a hardware interrupt stops the counter.

Thus, the counter value becomes a logarithmically scaled representation of the battery voltage. The counter value is stored in the A/D stack and is used (with the previous A/D readings) for slope calculations.

The log-A/D technique is inherently monotonic. It also normalizes slope calculations to accommodate a range of battery-pack voltages. Chargers designed for a fixed number of cells require only a two-resistor input-voltage divider. When the number of cells varies over a wider range, the Z8 adjusts the external attenuation network to perform autoranging. The addition of two resistors lets the circuit accommodate a 5:1 range in the number of cells. In this case, Z8 autoranging provides coarse adjustment of the initial A/D value within the converter's dynamic range. Each range allows sufficient A/D converter headroom for the expected change in battery voltage during charging.

Log A/D conversion simplifies the Z8 software. Consider the fact that the greatest change in battery voltage occurs when you bring a depleted battery to full charge. This gives the greatest start-to-finish voltage ratio (the worst-case condition in this discussion). Partially discharged batteries always exhibit a smaller start-to-finish voltage ratio. The worst-case start-to-finish voltage ratio is relatively constant for a given battery chemistry, and is thus predictable. Log A/D conversion transforms the start-to-finish voltage ratio in a given charging cycle into a constant algebraic difference. Similarly, you can easily compute any other percentage of change in battery voltage as the algebraic difference between the measured log A/D value and numerical constants used in the Z8's control program. Thus, the log A/D's normalizing property on battery-voltage measurements transforms the

offsets and thresholds used in inflection analysis to easily adjusted fixed values.

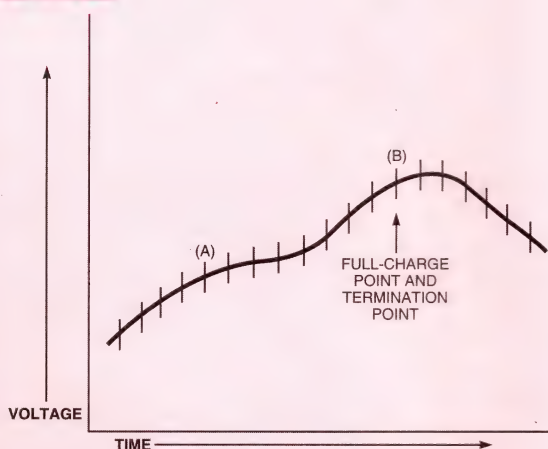
### Other features of the charging controller

In addition to  $dV/dt$ -inflection analysis, the Zilog battery-charging controller uses conventional methods of full-charge detection as secondary charge-termination techniques. The software includes provisions for minus-slope, minus-delta-voltage, temperature-cutoff, and total-charging-time terminations. Slope analysis accurately terminates charging before the battery temperature increases appreciably. However, you may wish to use temperature cutoff as a safety provision to suspend charger operation if charger components become too hot, as would occur if the charger's cooling air flow were accidentally blocked.

The Zilog smart-charging controller performs a series of tests when it detects battery insertion. One proprietary feature of the Z8 software is a technique called fast full-charge detection (FFCD). Because a charged battery will not exhibit the inflection characteristic seen in a normal charge cycle, this method relies on NiCd impedance characteristics, which vary as a function of the battery's state of charge. This test allows the Z8 to quickly sense a fully charged battery and prevent overcharging. In addition, the Z8 measures battery impedance before charging commences. High-impedance batteries are charged with lower current to prevent damage.

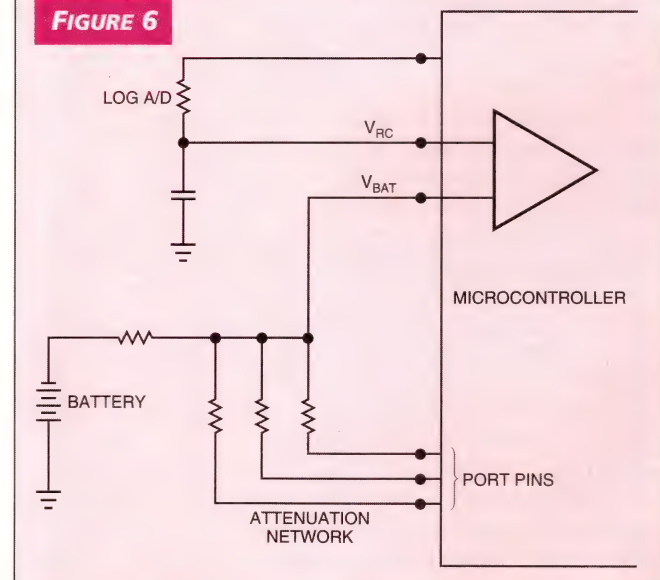
At the conclusion of a battery-charging cycle, the Z8 smart-charging controller reverts to an equalization mode in which very-low-current charging continues for a fixed time interval. This ensures that all cells in the pack charge fully. Inflection analysis is based on the overall  $dV/dt$  characteristics of the battery; individual cells within a pack will vary somewhat in their state of charge. An interval of low-current

FIGURE 5



If you sense the points at which the second derivative of the voltage vs time passed through zero during charging and terminate fast charging at the second of these inflection points, you will not overcharge the battery.

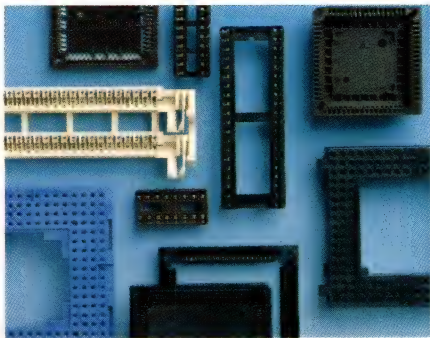
FIGURE 6



The Zilog/Black and Decker charger incorporates several additional innovations, including a logarithmic ADC and a switched attenuator controlled by a microcontroller port. This attenuator adapts the controller to work with battery packs containing different numbers of cells.



# Our delivery performance on sockets stacks up in your favor.



In a business environment where reduced inventories are a front-burner goal, mere claims about on-time delivery aren't much help. That's why we keep a scorecard on our own performance, measuring how well we meet—or miss—customer request dates.

Over the past 30 months, we've averaged better than 95% on our core socket line—the ones most heavily used. That means that better than 95% of all the orders we filled were delivered by the customer request date. This included SIMM, PGA, PLCC (99+%), DIP, and others.

They all came from ISO 9001-certified facilities: that's important. They all came with the quality and reliability you're looking for: that's important, too. And—for the record—95% of them came on time. Which could be very important in helping you control your inventory.

We understand what this can mean to your business. That makes it important to us. And that's why, if we promise to get your sockets to you on an agreed date, they'll be there.

AMP is a trademark.

**Scandinavia:** Sweden 46-8-580-833-00 (fax 46-8-580-194-70)

**Central Europe:** Holland 31-73-20-0911 (fax 31-73-21-2365); Germany 49-6103-7090 (fax 49-6103-709223); Great Britain 44-81-954-2356 (fax 44-81-954-6234)

**Southern Europe:** France 33-1-34-20-8888 (fax 33-1-34-20-8600); Italy 39-11-401-21111 (fax 39-11-403-1116); Spain 34-3-200-8466 (fax 34-3-201-7879)

CIRCLE NO. 47

# AMP



## FAST BATTERY CHARGERS

charging ensures that all cells in the pack are topped off. At the conclusion of this equalization mode, the Z8 reverts to maintenance mode, which compensates for battery self-discharge by periodically applying a brief pulse of charging current. Thanks to this feature, batteries can remain in the charger indefinitely without losing charge.

The Zilog/Black and Decker smart-charging controller includes several other innovative features. A 9600-bps serial data output provides A/D readings, slope values, and other charging parameters to any external device configured to receive the data. Thus, external devices can use the Z8 as a charging monitor. To demonstrate this capability, Zilog provides diagnostic software that runs on IBM-compatible PCs. The program displays the charging battery's voltage graphically, in real time, and also displays other pertinent data.

Although this article deals mostly with NiCd batteries, inflection analysis also applies to NiMH, lead-acid, lithium-ion, and other rechargeable-battery chemistries. The various battery types exhibit differences in the shape of their  $dV/dt$  characteristics, but the inflections occur predictably. In lead-acid batteries, the second  $dV/dt$  inflection occurs at a predictable interval before the batteries reach full charge, but from the battery's Ahr capacity rating, you can easily derive the duration of the incremental charging needed to achieve full charge. The techniques discussed here make fast battery charging effective and inexpensive. Moreover, because they are based on software, the methods adapt easily to specialized requirements.

EDN

## Authors' biographies



*Daniel Brotto is a project engineer for the US Power Tools group at Black and Decker Corp in Towson, MD. He has worked at Black and Decker for 14 years in electronics R and D and product development. His primary concentration is in the implementation of low-cost battery chargers, a field in which he has several patents pending. Brotto holds a BSCS from Loyola College, Baltimore.*

*Gary Cummings is president of Spectra Research, an engineering firm in Lake Forest, CA. He specializes in electronics design for consumer products and assists Zilog with system applications for Z8 microcontrollers. He received a BSEE from the University of Salt Lake City in 1976. He is a member of the IEEE.*



*James Goodhart is channel manager at Zilog Inc, where he has worked for four years. He is responsible for the Z8 microcontroller business, focusing on battery charging, infrared remote, and automotive applications. He attended San Jose State University and is a member of the Society of Automotive Engineers and the Joint Electron Devices Engineering Committee.*

## VOTE

Please use the Information Retrieval Service card to rate this article (circle one):

High Interest  
598

Medium Interest  
599

Low Interest  
600



**Get the edge...**

**...with Distribution Support**

## AUSTRIA

## ECD GmbH

Tel. 0043 222 6945170  
Fax. 0043 222 694510

## Eurodis Electronics GmbH

Tel. 0043 222 610630  
Fax. 0043 222 61062151

## Unielecronic

Tel. 0043 222 31872700  
Fax. 0043 222 3692273

## BELGIUM

## Alcom Electronics NV/SA

Tel. 0032 3 4583033  
Fax. 0032 3 4583126

## Farnell Electronic Services

Tel. 0032 2 7253533  
Fax. 0032 2 7254135

## Unielecronic/Diode

Tel. 0032 2 7254660  
Fax. 0032 2 7254511

## DENMARK

## Topcomp Electronics

Tel. 0045 33 88 39 50  
Fax. 0045 33 88 39 55

## FRANCE

## Arrow Electronics

Tel. 0033 1 49784978  
Fax. 0033 1 49780596

## Avnet

Tel. 0033 1 49652500  
Fax. 0033 1 49652769

## Farnell

Tel. 0033 1 64460200  
Fax. 0033 1 64463898

## Tekelec Airtronic

Tel. 0033 1 46232425  
Fax. 0033 1 45072191

## FINLAND

## Topcomp Electronics

Tel. 00358 0299 4001  
Fax. 00358 0299 4188

## GERMANY

## Farnell Electronic Services GmbH

Tel. 0049 7141 487300  
Fax. 0049 7141 487210

## Glyn GmbH

Tel. 0049 6126 590222  
Fax. 0049 6126 590111

## HED Heinrich Electronic

Tel. 0049 89 60810620  
Fax. 0049 89 6098663

## Rein Components GmbH

Tel. 0049 2153 7330  
Fax. 0049 2153 733575

## Unielecronic Vertriebs

GmbH  
Tel. 0049 6103 3048  
Fax. 0049 6103 304201

## ITALY

## Avnet Adelsy

Tel. 0039 2 38103100  
Fax. 0039 2 38002988

## Compel S.P.A.

Tel. 0039 362 553991  
Fax. 0039 362 553967 988

## Fanton

Tel. 0039 2 48920341  
Fax. 0039 2 4597913

## Farnell

Tel. 0039 2 824701  
Fax. 0039 2 8242831

## Lasi Elettronica (Div. Di Silverstar)

Tel. 0039 2 661431  
Fax. 0039 2 66101385

## NETHERLANDS

## Alcom Electronics

Tel. 0031 10 4519533  
Fax. 0031 10 4586482

## Farnell Electronic Services

Tel. 0031 79 613161  
Fax. 0031 79 613169

## Rein Elektronik B.V.

Tel. 0031 40 431775  
Fax. 0031 40 435522

## Unielecronic/Diode Components B.V.

Tel. 0031 3402 91234  
Fax. 0031 3402 35924

## Unielecronic/Diode Components B.V.

Tel. 0031 40 545430  
Fax. 0031 40 535540

## NORWAY

## Topcomp Electronics

Tel. 0047 66 84 18 15  
Fax. 0047 66 84 19 17

## SPAIN

## Lober S.A.

Tel. 0034 1 3102925  
Fax. 0034 1 3104797

## Unitronics S.A.

Tel. 0034 1 5425204  
Fax. 0034 1 5484228

## SWEDEN

## Topcomp Electronics

Tel. 0046 8 757 41 75  
Fax. 0046 8 757 47 98

## SWITZERLAND

## Eurodis Electronic A.G.

Tel. 0041 1 8433330  
Fax. 0041 1 8433900

## Fabrimec Distributions

A.G.  
Tel. 0041 1 3868686  
Fax. 0041 1 3832379

## Farnell A.G.

Tel. 0041 1 2046111  
Fax. 0041 1 2046454

## UNITED KINGDOM

## Abacus Group

Tel. 0044 635 33311  
Fax. 0044 635 38432

## Anzac Components Ltd

Tel. 0044 628 604411  
Fax. 0044 628 660662

## Avnet Access

Tel. 0044 462 480888  
Fax. 0044 462 488567

## Farnell Electronic Services

Tel. 0044 279 626777  
Fax. 0044 279 441687

## HB Electronics

Tel. 0044 204 25544  
Fax. 0044 204 384911

## Impulse Electronics Ltd

Tel. 0044 732 743227  
Fax. 0044 732 743121

## Toshiba European Headquarters:

## Toshiba Electronics

Europe GmbH  
Hansaallee 181  
D-40549 Düsseldorf  
Tel: 0049 211 52960  
Fax: 0049 211 5296400

## Toshiba Electronics Espana S.A.

Tel: 0034 1 660 6700  
Fax: 0034 1 660 6799

## Toshiba Electronics Italiana S.R.L.

Tel: 0039 39 6057234  
Fax: 0039 39 6057252

## Toshiba Electronics France S.A.R.L.

Tel: 0033 1 48124812  
Fax: 0033 1 48945115

## Toshiba Electronics (UK) Ltd

Tel: 0044 276 694600  
Fax: 0044 276 682256

## Toshiba Electronics Scandinavia AB

Tel: 0046 8 7040900  
Fax: 0046 8 808459

In Touch with Tomorrow

**TOSHIBA**





# Get The Edge in ASIC

Technology leadership is our business - and it shows.

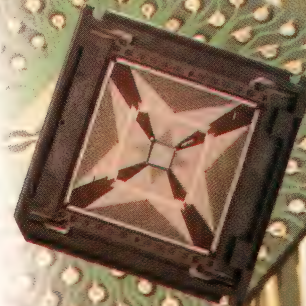
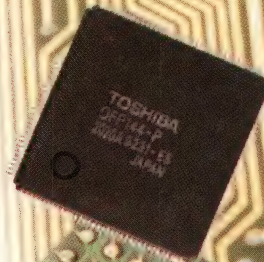
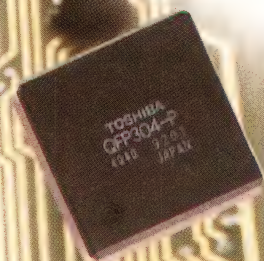
Toshiba extends the frontiers of innovation in ASIC, with usable, high reliability solutions offering the optimum performance/price ratio for your needs.

0.5 micron 560K Gate Arrays, Standard Cell and Embedded Arrays are available in many configurations including a 3V core with selectable active output buffers to interface to 5V components. System solutions incorporating  $\mu$ C, EEPROM and analogue functions are possible.

The package range includes low profile PFPs, lead spacing down to 0.4mm with 300-plus leads and heat spreader packages offering ceramic thermal performance at lower cost. In addition, new packages such as Ball Grid Arrays are currently under development.

There's local engineering support from European design centres to tailor these technologies to your application, and interface with prototyping and production facilities.

That's why when you specify Toshiba ASICs, you automatically build in a competitive advantage.



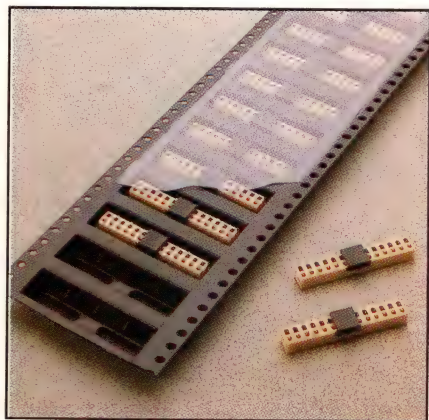
In Touch with Tomorrow  
**TOSHIBA**  
CIRCLE NO. 110





# If you were 4,000 miles from spare parts, what 2mm connector would you spec?

For 2mm, trust 3M. Now available in convenient tape-and-reel packaging.



When it comes to reliability, 3M's 2mm connectors are second to none. They're tough enough to withstand the high-temp rigors of infrared and vapor phase soldering — without warping or blistering. They're compatible with vacuum pick-and-place equipment, providing precise placement every time. And, they possess the same 3M quality construction and durability that hallmarks every one of our products.

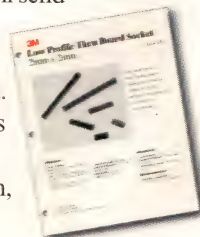
All of which means that they'll provide years of trouble-free service to the people who depend on your products day and night, even if that night lasts for months at a time.

Of course, those same qualities also mean you'll enjoy fewer manufacturing

problems, especially when you take advantage of our tape-and-reel packaging.

3M offers a full line of 2mm connectors, as well as custom engineering support. No matter what you need, we can build it. In fact, you could go to the ends of the Earth and not find a better, more reliable connector, or a more responsive supplier.

So, if failure leaves you cold, call 1-800-354-1919 and we'll send you more information on some of the hottest 2mm connectors around. 3M Electronic Products Division, 6801 River Place Boulevard, Austin, Texas, 78726-9000.



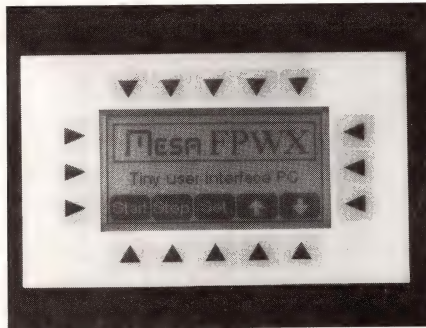


## FREE INFO, FREE POSTAGE

Use our postage-paid reader-service cards to get more information on any of these products.

**PowerPC motherboards suit high-volume products.** The PowerPC-based Ultra and Atlas are low-profile and Baby-AT motherboards, respectively. They use a PowerPC 603 or 604  $\mu$ P with 8 to 128 Mbytes of parity DRAM and a PCI local bus for I/O peripherals. Both chips implement the PCI bus, minimizing bottlenecks in moving data between memory and the peripheral controllers. The chips will be available in the fourth quarter for \$1000 (1). **Motorola Computer Group**, Tempe, AZ. (602) 438-3481. **Circle No. 318**

**PCMCIA card links desktops and portables.** Outback, the newest member of the CardDock family of universal PC-card readers and writers, supports PCMCIA types I, II, and III cards. The rear-loading unit mounts into a 16-bit ISA AT slot, supports 5 and 3V PC cards, and both reads and writes 3.3V cards. It complies with PCMCIA version 2.0. \$99 (1), \$59 (OEM). **Greystone Peripherals Inc.**, Los Gatos, CA. (408) 866-4739. **Circle No. 319**



**Tiny, PC-compatible computer has graphics display.** The PC-compatible FPWX includes an LCD graphics display in a thin, flat package measuring 2.6x4.5x1 in. The display has a 128x64-pixel monochrome, graphic, back-lit or reflective LCD. The CPU is a 9.2-MHz processor with 128 or 512 kbytes of system RAM, 128 or 256 kbytes of BIOS EPROM, and a socket for one 128- to 512-kbyte disk-emulator EPROM or flash EEPROM. A 64-pin PC-104 bus pinout-compatible header provides expansion. Adapters are available for ISA bus and PC-104 cards. The basic system with 128-kbyte RAM costs \$249 (100). **Mesa Electronics**, Emeryville, CA. (510) 547-0837. **Circle No. 320**

# Measure It All!

## The DMM/LCR Meter/ Frequency Counter. All in One.

**T**roubleshoot down to the component level — any component! Verify poorly marked parts, test for tolerances and damage. Wavetek's new DM27XT is not only a full-function DMM, but also includes complete inductance, capacitance, and frequency measurement capabilities.

- **Wide LCR range:**  
10  $\Omega$  to 2000 M $\Omega$   
10 pF to 2000  $\mu$ F  
100 pH to 20 H
- **Autorangeing frequency meter** 10 Hz to 20 MHz
- **Ac and dc current to 20 A**
- **Logic test, diode test, max reading hold, continuity beeper, input warning beeper, fused input protection, battery saver**

Consolidate your test bench with one meter that does it all — Wavetek's high-performing, full-function XT Series DMM. It's all in one compact, rugged, field-ready package with a big 0.7-inch, 3 1/2-digit display. Insulated probes and alligator clip leads are included, and there is a huge selection of accessories, including current, rf and HV probes, temperature converters, holsters, and cases. Ask for Wavetek DMMs. They're the meters to pick when you have things to fix.



# \$119<sup>95</sup>

Other XT Series DMMs from \$89.95

U.S.A.: (619) 279-2200  
Europe: (44) 243 531323  
Asia Pacific: (852) 865-1903

©1993 Wavetek Corporation



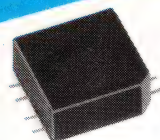
# WAVETEK

CIRCLE NO. 115



# PICO

## Low Profile. 2" Ht Surface Mount Transformers & Inductors



Actual  
Size

All PICO surface mount units utilize materials and methods to withstand extreme temperature (220°C) of vapor phase, IR, and other reflow procedures without degradation of electrical or mechanical characteristics.

### AUDIO TRANSFORMERS

Impedance Levels 10 ohms to 10,000 ohms, Power Level 400 milliwatt, Frequency Response  $\pm 2$ db 300Hz to 50kHz. All units manufactured and tested to MIL-T-27.

### POWER and EMI INDUCTORS

Ultra-miniature Inductors are ideal for Noise, Spike and Power Filtering Applications in Power Supplies, DC-DC Converters and Switching Regulators. All units manufactured and tested to MIL-T-27.

### PULSE TRANSFORMERS

10 Nanoseconds to 100 Microseconds. ET Rating to 150 Volt-Microsecond. All units manufactured and tested to MIL-T-21038.

Delivery—  
stock to one week

**PICO**  
**Electronics, Inc.**

453 N. MacQuesten Pkwy. Mt. Vernon, N.Y. 10552

Call Toll Free **800-431-1064**

IN NEW YORK CALL **914-699-5514**

FAX **914-699-5565**

CIRCLE NO. 138

EDN

COMPUTERS & PERIPHERALS

### Controller simultaneously drives true-color flat panels and high-res- olution CRTs.

The AV540 stand-alone flat-panel CRT controller drives flat-panel displays with up to 24 bits/pixel color depth and up to 1280×1024-pixel resolution. The board also drives a CRT simultaneously with resolutions up to 1024×768 pixels and 256 colors. An on-board dc/dc converter supports all display types, including TFT, single-scan STN, dual-scan STN, electroluminescent, and plasma flat panels. FRC and dithering generate more colors on a panel and reduce panel flicker. The controller supports direct input of 18-bit RGB data with hardware x-y or color keying to support live video windows on flat panels. A fully loaded board costs \$299 (100). AVED, Tustin, CA. (714-573-5000).

**Circle No. 321**

### DRAM card holds 20 Mbytes.

The JEIDA/JEDEC-standard 16-Mbyte, credit-card-sized IC DRAM cards expand the internal memory of a laptop from 4 to 20 Mbytes. The 88-pin cards operate as low as 3.3V with access times of 70 nsec. The cards can extend a laptop's battery life when applications access the card instead of directly accessing the machine's internal disk drive. \$1070 (1000). IBM Microelectronics, Fishkill, NY. (800) 426-0181, ext 929.

**Circle No. 322**

### Keyboard connects to printer port.

The full-sized Parallel Keyboard 101 connects to notebooks and subnotebooks via the printer port. By using a T connector, you can connect both the printer and the keyboard to the computer simultaneously. The keyboard consumes <1 mA, which has virtually no effect on the computer's battery life. You can customize the keyboard with special macros. A 102-key version is available for international use. \$115. Genovation Inc, Irvine, CA. (800) 822-4333.

**Circle No. 323**

### Workstations use SuperSPARC.

Two new SuperCompstation 20 desktop workstations use Sun's SuperSPARC chip set. Model 20A-50 uses a 50-MHz processor to deliver 69 SPECint92 and 78 SPECfp92 performance; the 60-MHz 20A-61 increases performance to 89 SPECint92 and 103 SPECfp92. Entry-level systems include a 2D/3D Turbo GX graphics accelerator, a 20-in. color monitor, and 32 Mbytes of RAM. Model 20A-50 includes a 520-Mbyte hard drive; Model 20A-61 has a 1-Gbyte

drive and 1 Mbyte of super cache. From \$12,500. Tatung Science and Technology Inc, Milpitas, CA. (408) 383-0988.

**Circle No. 324**

### Slide scanner increases digitizing speed.

The SprintScan 35-mm slide scanner digitizes images at maximum resolution in 30 sec. The scanner scans in one pass, corrects color, and sharpens the image. Maximum output resolution is 2700 dpi. The scanner accepts color and black-and-white, 35-mm transmissive film, including positive and negative and mounted or unmounted transparencies and film strips. It has a standard SCSI-2 interface. \$2500. Polaroid Corp, Cambridge, MA. (800) 662-8337.

**Circle No. 325**



### PCMCIA card provides parallel I/O.

The IOP-241 PCMCIA card allows parallel communication between PCs and external devices. It provides up to 24 digital I/O signals, each of which can be configured as input or output. Each of the 24 signals are buffered, to enhance the card's drive capability and can be used as interrupt sources. The card complies with PCMCIA version 2.1 and plugs into Type II PCMCIA sockets. \$229. Quatech, Akron, OH. (216) 434-3154.

**Circle No. 326**

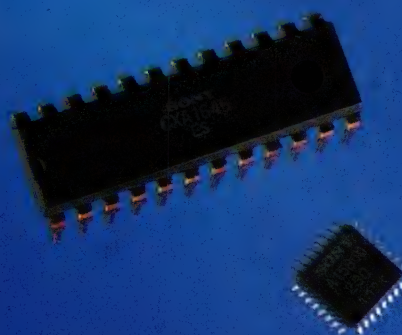
### Computers put Pentium in indus- trial package.

The StealthRack Pentium PCs put 60- and 66-MHz Pentium processors in rugged packages. The systems offer RAM expansion of up to 64 Mbytes, disk drives from 200 Mbytes to 2.1 Gbytes, and seven full-length expansion slots, including three with the VESA local bus. Other options include dc operation, tape backup, CD-ROM, PCMCIA, and redundant power supplies. The system's main board incorporates I/O, IDE, SCSI, and floppy controllers. From \$3200. Stealth Computer Corp, Toronto, ON, Canada. (416) 674-3800.

**Circle No. 327**



# SONY. CONVERTING THE WORLD WITH THE BEST ENCODERS AND DECODERS.



ENCODER/DECODER IC								
Type		Functions		Features		Voltage (V)	Package	
		Input	Output	TV system	Others			
CXA1645M/P	Encoder	R.G.B	Composite video	NTSC/PAL	Built-in BPF + DL	5	24P SOP DIP	
CXA1229M/P		Y•color difference			75 Ω drivers for R.G.B outputs and composite video outputs			
V7040		R.G.B			Super impose function 75 Ω drivers for R.G.B outputs and 2 systems of composite video outputs		28P SDIP	
CXA1228S	Decoder	Composite video	Y•color difference		Composite sync Sub carrier Line alternate Burst flag		-outputs	28P SDIP
CXA1585Q			R.G.B					32P QFP

Nobody outperforms Sony in converting analogue RGB/composite video signals. Its wide range of Encoder and Decoders is packed with advanced features needed to improve performance in applications like: *Multimedia PC tasks, D2MAC Satellite Receivers, Liquid Crystal TVs and VCRs.*

Take the new CXA1645 Encoder. It has a built-in Bandpass Filter (BPF) for the chroma signal, and Delay Line for the luminance channel – cutting out the need for expensive, bulky external components! Whilst features which are common to the range – low power consumption, PAL/NTSC compatibility, and space saving surface mounts – maintain the Sony reputation for built-in quality.

In fact, as a world leader in the design and manufacture of advanced semiconductors Sony offers much more than superior Encoders/Decoders. Its capacity for high volume production capacity allied to high level technical support is your guarantee of ultimate quality.

For more information on the way Sony can convert *you* to its leading edge technology, please contact your local sales office.

Sony International Offices:

United Kingdom: SSE, UK Sales. Tel: +44 932 816175.

Germany, Switzerland & Austria: Sony Europa GmbH, CPCE. Tel: +49 89 82916 442.

France & Spain: Sony France SA, Semiconductor Department. Tel: +33 1 40 87 33 86.

Scandinavia, Italy & Other Areas: Tel: +44 256 478771 (Ext. 407).

Alternatively, write to Donna Crowley at:

**Headquarters: Sony Semiconductor Europe, Priestley Road, Basingstoke, Hants RG24 9JP. Tel: +44 256 478771 (Ext. 432). Fax: +44 256 818194.**

## SONY®



# Traceable 10 MHz Calibration Standard with Cesium Stability

**\$4950** (U.S. list)

Atomic clocks have long been the recognized standard for applications requiring a highly accurate and stable frequency reference.

**Now there's a low cost alternative.**

The FS700 is a LORAN-C based frequency standard that provides the long-term stability of a Cesium clock ( $10^{-12}$ ) with NIST traceability. LORAN-C timing signals are transmitted by over 90 stations throughout the northern hemisphere, guaranteeing reception in North America, Europe and many parts of Asia.

Why use LORAN-C? The advantages are clear.

The FS700 delivers Cesium clock performance without the high price and maintenance costs of an atomic standard. Additionally, the FS700 provides dependable reception and higher stability than WWVB and GPS systems.

The FS700 LORAN-C Frequency Standard is the optimum, cost effective solution for all your frequency management and calibration needs. Contact SRS for more information on the FS700 and our complementary line of high resolution synthesizers and precision counters.

- **10 MHz NIST traceable standard**
- **Cesium long-term stability ( $10^{-12}$ )**
- **$10^{-10}$  short-term stability ( $10^{-11}$  optional)**
- **Four 10 MHz sinewave outputs**
- **Variable frequency output (TTL)**
- **Phase comparator for calibrating external timebases (0.01 Hz to 10 MHz)**



**FS700 - The Optimum Frequency Management System**



**STANFORD RESEARCH SYSTEMS**  
1290-D Reamwood Avenue, Sunnyvale, CA 94089  
TEL (408)744-9040 • FAX (408)744-9049

CIRCLE NO. 186

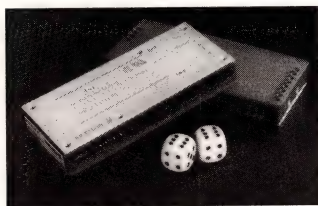


## FREE INFO, FREE POSTAGE

Use our postage-paid reader-service cards to get more information on any of these products.

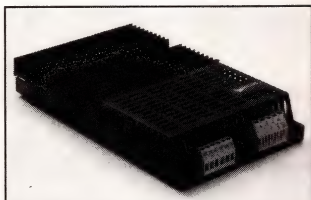
**Rechargeable-battery snap bollixes 9V primary batteries.** A battery snap for 7.2 or 8.4V NiCd rechargeable batteries has a third contact that precludes users from connecting conventional 9V primary batteries. The third contact strikes a plate found only on rechargeable batteries. \$0.40 (1000); delivery, stock to four weeks ARO. **Memory Protection Devices Inc.**, Farmingdale, NY. (516) 293-5891. **Circle No. 341**

**PCMCIA power controller replaces forest of MOS-FETs.** The MIC2560 is a PCMCIA-slot power controller that manages the profusion of both main-supply and programming voltages. The controller's 16-pin surface-mount package fits between a PCMCIA controller and a PCMCIA socket, replacing six to 10 MOSFETs and associated glue logic. The device's outputs are short-circuit- and overvoltage-protected. \$2.96 (1000). **Micrel Semiconductor**, San Jose, CA. (408) 944-0800. **Circle No. 342**



**DC/DC converter models second-source AT&T FW series.** The 150W PKU 4111 PI and the 100W PKU 4110 PI are single-output, 5V dc/dc converters. The units accept 36 to 72V dc. The converters have the same pinouts as AT&T's FW series but offer a smaller footprint, and they operate to 100°C with optional heat sinking. Unlike most such board-mounted, high-power converters, these units are not

potted; their metal cases' sides have perforations, allowing cross ventilation, even with optional heat sinks mounted. \$146 (100). **Ericsson Components Inc.**, Richardson, TX. (214) 997-6561. **Circle No. 343**



**Switching power supplies get enhanced.** The FlatPac family of modular off-line switching power supplies now features an autoranging input, module-disable inputs, and compliance with VDE and FCC EMI regulations. The switchers integrate one, two, or three of the maker's dc/dc converters in a single chassis. The factory assembles the switchers to user specifications. \$0.85/W in OEM quantities. **Vicor Corp.**, Andover, MA. (508) 470-2900. **Circle No. 344**

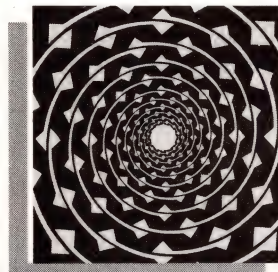
**10W dual-output dc/dc converter measures 1x2x0.4 in.** The SR series of 10W dc/dc converters features 81% efficiency max. The converters accept 12, 24, or 48V dc. Outputs are  $\pm 5$ ,  $\pm 12$ , or  $\pm 15$ V. Noise is 70 mV p-p from 0 to 20 MHz typ. The converters work from -40 to +85°C. \$43.99 in OEM quantities. **Calex Mfg Co Inc.**, Concord, CA. (510) 687-4411. **Circle No. 345**

**Charger handles NiCd, NiMH, and lead-acid batteries.** The Gang Charger simultaneously recharges from one to eight battery packs containing NiCd, nickel-metal-hydride (NiMH), and sealed lead-acid battery packs from a wall outlet. \$30 in OEM quantities. **Venture Technologies Inc.**, North Billerica, MA. (508) 667-9890. **Circle No. 346**

## Conference &amp; Exhibition

## MICRO SYSTEM Technologies 94

4th International Conference and Exhibition on Micro Electro, Opto, Mechanical Systems and Components



## Top in MST:

More than 100 international experts report on:

- Packaging and Interconnection
- Materials and Technologies
- Sensors/Actuators
- System/Component Design
- Micro Optics
- Biological Based Microsystems
- Applications

*Come, listen, see ...  
(Ask for detailed information!)*

**ICC International Congress Centre Berlin** Oct. 19-21, 1994

## COUPON:

Please send me the complete information material.  
I am interested in MICRO SYSTEM Technologies as

MESAGO  
Messe & Kongress GmbH  
Rotebuehlstrasse 83-85  
D - 70178 Stuttgart  
Tel.: +49-711-61946-0  
Fax: +49-711-61946-92

☐ Exhibitor ☐ Conference attendee ☐ Visitor

Name

Company

Street

Postal Code

Phone

Fax

EDN

CIRCLE NO. 87



### External ac/dc power supplies come with optional NiCd charger.

Single-output, 25W versions of the CL family of external 25 and 40W ac/dc switching power supplies come with an optional NiCd-battery-charging circuit. The supplies accept 90 to 264V ac at frequencies ranging from 47 to 440 Hz. Outputs are  $\pm 5$ ,  $\pm 12$ , 9.5, 24, or 48V dc. The switchers meet FFC, UL, CSA, VDE, and BABT EMI and safety standards. 25W models cost \$35 to \$40, and 40W

models cost \$55 in OEM quantities. Computer Products/Power Conversion America, South Boston, MA. (617) 268-1170. **Circle No. 347**

### DIP-sized dc/dc converters accept wide input-voltage range.

The TWB series of 24-pin DIP-sized dc/dc converters accepts 9 to 36V dc or 18 to 72V dc. The series outputs are 5, 12, 15,  $\pm 12$ , or  $\pm 15$ V. The converters have

input  $\pi$  filters. The devices measure 0.8 $\times$ 1.25 $\times$ 0.40 in. and have 500V isolation. \$15.85 in OEM quantities; delivery, stock to four weeks ARO. Polytron Devices Inc, Paterson, NJ. (201) 345-5885. **Circle No. 348**

### DC/DC converters have 2000V isolation.

The 2001 series of single- and dual-output 5W dc/dc converters have 2000V (5000V pk) input/output isolation. The units are UL 1950 and CSA 22.2 approved. Four models operate from 5 or 12V dc inputs, providing -9 or +5 and +10V-dc outputs. The supplies measure 1.30 $\times$ 1.30 $\times$ 0.375 in and operate over -30 to +75°C. \$36 to \$40 (100); delivery is stock to four weeks ARO. Conversion Devices Inc, Brockton, MA. (508) 559-0880. **Circle No. 349**

## Try the Workhorse that's Always Ready to Charge! IC's Extended Endurance Aluminum Electrolytic Capacitors.

Whether you're building new circuits or maintaining old ones, **CKR** radial lead and **TIA** axial lead aluminum electrolytics from IC will keep them doing a great job. Designed with endurance ratings of 2000 hours at 85°C, they provide performance and reliability and are ideally suited for bypass, coupling, blocking and filtering applications.

- $\leq 0.006$ cv leakage current.
- **CKR**: 0.1 to 15,000 mfd, 6.3 to 250 wvdc.
- **TIA**: 0.47 to 22,000 mfd, 6.3 to 450 wvdc.
- Capacitance tolerance  $\pm 20\%$  (M);  $\pm 10\%$  (K) optional; -10 to +30% (Q) optional.

**CKR/TIA** capacitors are in stock for immediate delivery. For complete details, contact your local IC distributor or IC.

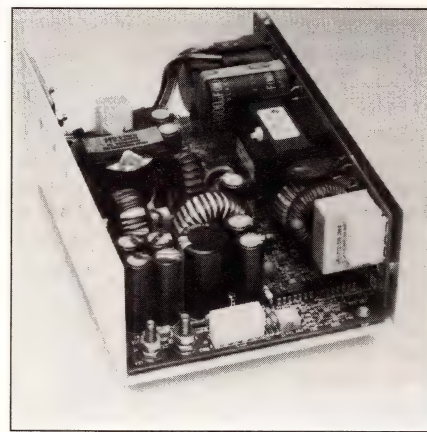
Ask for our **FREE** Capacitor Engineering Guide.



**ILLINOIS CAPACITOR, INC.**

3757 West Touhy Avenue, Lincolnwood, IL 60465  
708 675-1760 • FAX: 708 673-2850

**CIRCLE NO. 80**



### 375W supplies stand 2.5 in. tall.

The 124 series of low-profile, 375W supplies measures 5 $\times$ 7 $\times$ 2.5 in. The supplies accept 94 to 264V ac. All models meet UL, CSA, TUV, and BABT requirements. Outputs are +5V at 35A, +12V at 10A, -12V at 0.5A, and -5V at 0.5A. \$225 (1000); delivery, stock to eight weeks. Conversion Equipment Corp, Orange, CA. (714) 637-8654.

**Circle No. 350**

### AC front-end power distributed converters.

The PM33210P isolated (3000V) front end provides as much as 2.1 kW (48V at 48A) to distributed "brick" converters. You must power the unit from 180 to 264V ac to achieve 2.1-kW performance (1.2 kW from 85V ac). The supply measures 5 $\times$ 5 $\times$ 11.5 in. and is hot-swappable. The supply's active power-factor correction meets IEC 555-2. The unit also meets UL, CSA, and TUV requirements. \$795 (50). Pioneer Magnetics, Santa Monica, CA. (310) 829-6751.

**Circle No. 351**



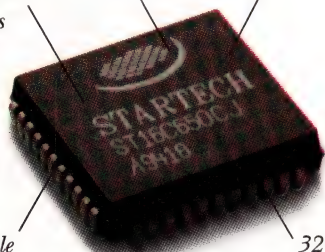
# Both are turbos with a V6 engine, but the one on the left will launch the next generation of modem devices.

28.8 Kb/sec baud rate  
(vs. 14.4 standard today)

Internal functions  
which allow direct  
interface to an  
IBM PC bus

Not too sexy looking

Pin selectable

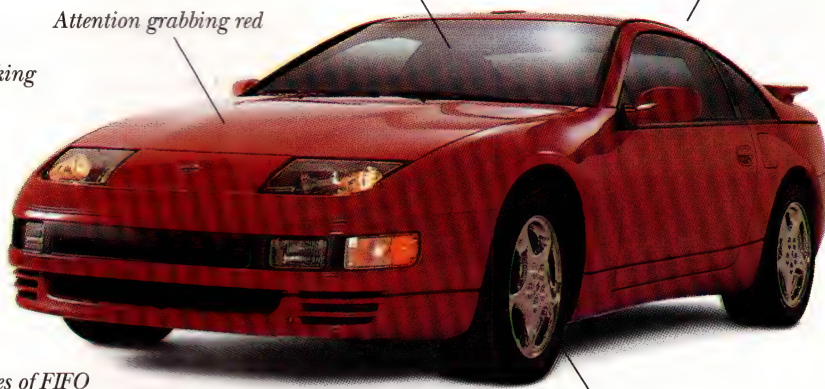


32 bytes of FIFO  
(vs. 16 on 550)

Attention grabbing red

Room for two

Undeniably sexy looking



Matching tires

*Startech's Turbo 16C650*

*Imported Sports Car*

Startech's new ST16C650 is going to help drive the next generation of modem devices. And while on the outside it may not look as flashy as an imported sports car, on the inside it is far more remarkable.

Compatible in footprint to our older 550, it is the first and only UART product to offer all of the following features in combination.

It has a 28.8 kb/sec baud rate, compared to today's standard of 14.4. It has 32

bytes of FIFO, compared to today's 16. Its internal functions allow direct interface to an IBM PC bus. It is pin selectable and has reduced software overhead thanks to Xon/Xoff handshaking. And it has a sleep mode that lets the chip power down automatically when there's no communication.

For more information on how the new ST16C650 can help launch your advanced modem products, or evaluation boards on all of our

products, call (800) 245-6781 or fax us at (408) 745-1269.

Together, we'll make the next generation of modem devices faster and better than ever. Then watch sales take off down the road.



**STARTECH**  
SEMICONDUCTOR, INC.

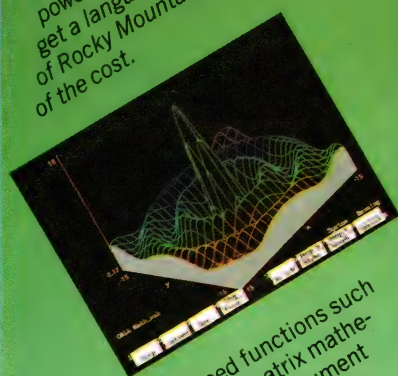
1219 Bordeaux Drive  
Sunnyvale, CA 94089  
(408) 745-0801



HTBasic

SCIENTIFIC  
BASIC

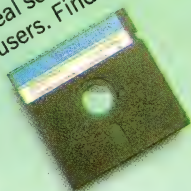
HTBasic can transform your PC into a powerful engineering workstation. You get a language with all the attributes of Rocky Mountain BASIC at a fraction of the cost.



HTBasic has advanced functions such as: complex arithmetic, matrix mathematics, and sophisticated instrument control. Our 32-bit-compiled routines boost high-speed calculations. And a full library of precompiled subroutines for FFTs, curvefitting, and waveform analysis speeds your development.

With HTBasic, your PC is compatible with the HP9000 Series 200/300. Our transfer utility even allows you to port your current BASIC programs to your PC and run them with little or no changes. You get all the capabilities needed for complex applications without sacrificing DOS compatibility.

HTBasic: the ideal scientific language for all technical users. Find out more today.



TransEra

Engineering Excellence for 15 Years™

3707 N. Canyon Road • Provo, UT 84604  
(801) 224-6550 • Fax (801) 224-0355

## FREE INFO, FREE POSTAGE

Use our postage-paid reader-service cards to get more information on any of these products.

**1-Mbit slow SRAMs have 64k×16-bit organization.** The ultralow-power MCM51016ALL SRAM draws a maximum standby current of 10  $\mu$ A from a 3V power supply. The MCM51016AL draws 50  $\mu$ A max standby current. Both devices draw a maximum of 100 mA of active current. The devices can hold data when the power supply drops to 2V, and they offer 70-, 85-, or 100-nsec access times. The devices come in a 44-pin standard or reverse-pinout TSOP. \$15.75 (10,000). **Mitsubishi Electronics America Inc**, Sunnyvale, CA. (408) 730-5900. **Circle No. 328**

**8-bit ADC takes 600M samples/sec.**

The TDA8718 samples at rates up to 600M samples/sec while maintaining an effective 8-bit signal bandwidth of 100 MHz. Power dissipation is 1.14W. The ADC's wide-bandwidth analog-input stage reduces the input capacitance to 5 pF and eliminates the need for S/H circuitry for input signals up to 150 MHz. Both the ends and center point of the on-chip reference ladder are available on package pins so that you can easily set digital zero and digital full scale using an external reference current and external resistors. The digital outputs are ECL-100k compatible. Around \$360 (10,000). **Philips Semiconductors**, Sunnyvale, CA. (408) 991-2101. **Circle No. 329**

**Regulators produce clean PCMCIA voltages.**

The LT1312 single and LT1313 dual regulators power and protect the VPP pins of standard PCMCIA card slots. Built-in current limit and thermal shutdown ensure that a short on either side of a standard socket doesn't damage the host computer or PC card. The regulators produce 0, 3.3, 5, and 12V and high-impedance outputs from any unregulated 13 to 20V supply, thus eliminating the need for an extra 12V regulator to generate clean VPP power. Quiescent current is 30  $\mu$ A for the single and 60  $\mu$ A for the dual regulator when you program them for the 0V or high-impedance modes. A single 1- $\mu$ F capacitor is the only external component required. In 8- and 16-pin SOICs, respectively, the LT1312 costs \$2.03, and the LT1313 costs \$3.03 (1000). **Linear Technology Corp**, Milpitas, CA. (800) 454-6327. **Circle No. 330**

**Data compression as fast as 40 Mbytes/sec.** The ALDC1-20S and 40S adaptive lossless data-compression chips allow 20- and 40-Mbyte/sec processing. The chips provide data-compression ratios greater than 2 to 1 in real time. The devices support multiprotocol DMA interfaces, industry-standard  $\mu$ P interfaces, eight/16 selectable data buses with selective parity checking, and 16-byte FIFO buffering and bypass mode. Both devices employ a 5V, 0.8- $\mu$ m CMOS process. The ALDC1-20S sells for \$38.30 (10,000). The ADLC1-40S sells for \$70.20 (10,000). **IBM Microelectronics**, Hopewell Junction, NY. (914) 892-5389. **Circle No. 331**

**Bus drivers designed for automotive diagnostics.**

The Si9241EY and Si9243EY narrow-body, small-outline bus drivers meet the ISO 9141 standard for communications between computers and diagnostic equipment. The series drives high capacitive loads, as defined by the ISO 9141 specification. In automobiles and external equipment, the devices replace as many as 20 discrete parts with an SO-8 package. \$0.89 for the Si9241EY and \$1.05 for the Si9243EY (OEM quantities). **Siliconix Inc**, Santa Clara, CA. (800) 554-5565, ext 29. **Circle No. 332**

**Encryption processor integrates DMA.**

Using two high-speed data-encryption-system engines, the Road-Runner284 cipher path processor provides a ciphering bandwidth of 284 Mbps. It also provides an I/O bandwidth of 640 Mbps using DMA controllers with FIFO buffers. The 208-pin device includes user-definable ROM and RAM and operates at a clock speed



# BEST 10-BIT SERIAL ADC FOR LOW-POWER DESIGNS – \$2.95<sup>†</sup>

## MAX192 Defines "Best":

### ◆ Best in Completeness:

- 10-Bit ADC with On-Chip
  - Voltage Reference
  - Track/Hold
  - 8-Channel Mux

### ◆ Best in Low-Power:

- Single +5V Supply
- 2 $\mu$ A Shutdown Current
- 100 $\mu$ A Operating Current
- (1 ksp/s, includes voltage reference!)

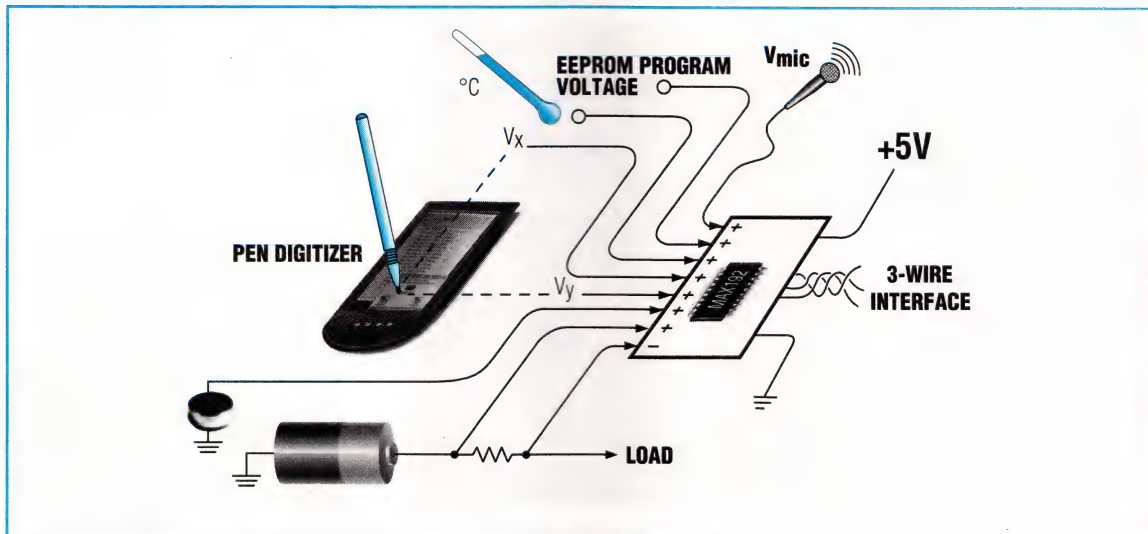
### ◆ Best in Performance:

- 133ksp/s Throughput
- Guaranteed No Missing Codes

### ◆ Best in Saving Space:

- Small 20-Pin SSOP/SO/DIP Packages
- Microwire<sup>™</sup>, SPI<sup>™</sup>, QSPI<sup>™</sup>, TMS320-Compatible Serial Interface

**Best Choice to Monitor Supplies, Temperatures, Batteries, and Sensors...**



Eight analog inputs are independently programmable for differential or single-ended, unipolar or bipolar signals via the serial interface.

**FREE A/D Converter Design Guide—Sent Within 24 Hours!**  
Includes: Data Sheets and Cards for Free Samples

CALL TOLL FREE 1-800-722-8266  
For a Design Guide or Free Sample

MasterCard® and Visa® are accepted for Evaluation Kits or small quantity orders.

**MAXIM**



Distributed by Arrow, Bell, Digi-Key, Elmo, Hamilton Hallmark, and Nu Horizons. Authorized Maxim Representatives: AL, M-Squared, Inc. AZ, Techni Source Inc. CA, Mesa, Pro Associates, Inc., Infinity Sales, Inc. CO, Component Sales CT, Comp Rep Associates DE, TAI Corporation FL, Sales Engineering Concepts GA, M-Squared, Inc. ID, E.S. Chase IL, Heartland Technical Marketing Inc. IN, Technology Marketing Group IA, JR Sales Engineering, Inc. KS, Delltron LA, BP Sales MD, Micro-Comp, Inc. MA, Comp Rep Associates MI, Micro Tech Sales MN, Mel Foster Technical Sales, Inc. MS, M-Squared, Inc. MO, Delltron MT, E.S. Chase NE, Delltron NV (Reno, Tahoe area only) Pro Associates, Inc. NH, Comp Rep Associates NJ, Parallax, TAI Corporation NM, Techni Source Inc. NY, Parallax, Reagan/Compar NC, M-Squared, Inc. OH, Lyons Corporation OK, BP Sales OR, E.S. Chase PA (Pittsburgh area) Lyons Corporation, (Philadelphia area) TAI Corporation SC, M-Squared, Inc. TN, M-Squared, Inc. TX, BP Sales UT, Luscombe Engineering Co. VA, Micro-Comp, Inc. WA, E.S. Chase WI, Heartland Technical Marketing, Inc.  
Distributed in Canada by Arrow. Authorized Maxim Representative in Canada: Tech Trek.

Austria, Allmos Electronics Belgium, Master Chips Denmark, Exatec A/S Finland, Yleiselektronikka Oy, France, Maxim France, France/Distributors: Maxim France, ASAP Germany, Maxim GmbH Germany/Distributors: Maxim GmbH, Spezial Electronic KG Ireland, FMG Electronics Italy, Consystem S.r.l., Italy/Distributor: Esco Italiana Electronics Supply Netherlands, Koning En Hartman Norway, Odin Electronics A/S Poland, Uniprod, Ltd. Portugal, ADM Electronics, S.A. Spain, ADM Electronics S.A. Sweden, Egevo AB Switzerland, Laser & Electronic Equip. Turkey, Interex (U.S.A.) U.K. Maxim Integrated Products (U.K.), Ltd., U.K./Distributors, Maxim Integrated Products (U.K.), Ltd., 2001 Electronic Components, HB Electronic

†FOB USA direct resale for 25,000-pieces Maxim is a registered trademark of Maxim Integrated Products. © 1994 Maxim Integrated  
™ SPI and QSPI are trademarks of Motorola, Microwire is a trademark of National Semiconductor.



of 40 MHz. It costs \$75 (10,000). **Semaphore Communications**, Santa Clara, CA. (408) 980-7750.

**Circle No. 333**

**Frequency synthesizers target cellular and cordless standards.** The SA7025 and SA8025 fractional-N dual-frequency synthesizers integrate a high-frequency prescaler with a fractional-N PLL synthesizer on a single

chip. These ICs target the North American IS-54 and Japanese PDC-800 standards. The 7025 provides coverage to 1 GHz, and the 8025 operates to 2 GHz. Both include an auxiliary 150-MHz synthesizer to create offset frequencies or a fixed second local-oscillator signal. To switch quickly from channel to channel without excessive phase noise, the ICs implement adaptive filtering with a programmable speed-up mode that uses two filter designs with differ-

ent charge-pump currents. In 20-pin SSOPs, the 7025 and 8025 cost \$6.50 and \$8 (1000), respectively. **Philips Semiconductors**, Sunnyvale, CA. (800) 447-1500, ext 3012.

**Circle No. 334**

**Low-dropout regulators work at 3.3V.** The LP2952-3.3 and LP2953-3.3 deliver 250 mA of output current while exhibiting dropout voltages of 470 mV at full load. Quiescent current is 130  $\mu$ A at a load of 1 mA. Both regulators have a 3.3V voltage tap that lets you set the 3.3V output without using external resistors. Both devices also include an electronic shutdown pin, which you can use to reduce current to a maximum of 140  $\mu$ A. An error flag indicates when the regulators have fallen out of regulation by more than 5%. The LP2952 comes in 14-pin DIPs and 16-pin SOICs; prices start at \$2. The LP2953, which includes an auxiliary comparator, comes in 16-pin DIPs and SOICs; prices start at \$2.30. **National Semiconductor**, Santa Clara, CA. (408) 721-7509.

**Circle No. 335**

## Great Things . . . Small Packages!



### Ecliptek Introduces the ECCM1 1.3 MM Ceramic SMT Crystal for PCMCIA

- Designed For All PCMCIA Applications
- Lowest Profile Industry Standard Package
- Gold Sealed For Optimum Performance
- Common Chipset Specifications In Stock
- Frequency Range From 11.0592MHz to 150.000MHz
- Tape And Reel Standard For Automatic Insertion

**Crystals • Clock Oscillators • Inductors**

*For Further Information, Contact:*

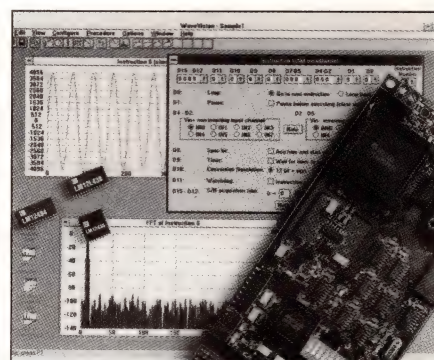


**ECLIPTEK**  
CORPORATION

3545 Cadillac Ave. • Costa Mesa, CA 92626  
Fax: (714) 433-1234

**1-800-ECLIPTEK**

**CIRCLE NO. 77**



**Data-acquisition systems have flexible serial interface.** The LM12434/8 and LM12L438 12-bit ICs don't require any glue logic to connect to nearly all popular  $\mu$ Ps. They are directly compatible with Microwire/PLUS, SPI/QPSI, the TMS320 family, 8051s, and the I<sup>2</sup>C interface for true two-wire serial communications. These devices combine an analog front end—four- or eight-channel input multiplexer, 12-bit plus-sign ADC with S/H, single-ended or differential inputs—with numerous digital features—an 8-word instruction register, a 16-bit programmable timer, and a FIFO buffer. A shutdown mode drops typical power consumption to 25  $\mu$ W at 5V. The devices come in 28-pin PLCCs or SOICs, and prices range from \$16.60 to \$18.90 (1000). A design kit costs \$195. **National Semiconductor**, Santa Clara, CA. (408) 721-5831.

**Circle No. 336**



# BEST 500Msps 8-BIT ADC DELIVERS 7.1 EFFECTIVE BITS AT NYQUIST

- ◆ **Best** Effective Bits vs. Frequency (7.1 ENOB @ Nyquist)
- ◆ **Best** Signal-to-Noise-and-Distortion (43dB @ Nyquist)
- ◆ **Best** Input Resistance (50Ω)
- ◆ **Best** Analog Input Bandwidth (1.2GHz)
- ◆ **Best** Aperture Jitter (<2ps)
- ◆ **Best** Input Capacitance (<2pF)
- ◆ **Best** Error Rate (<10<sup>-15</sup> Metastable States)

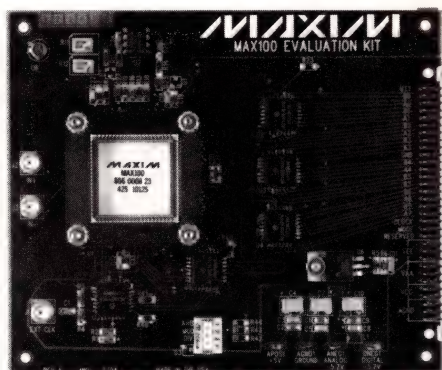
## Internal T/H Provides Superior Performance!

An internal track/hold, coupled with leading-edge circuit design and Maxim's proprietary world-class bipolar process, make MAX101 the highest performance solution for communications, radar, transient-event-capture, high-speed imaging, and other demanding high-speed applications. The MAX100 has 250Msps conversion rate and can be used for lower cost applications.

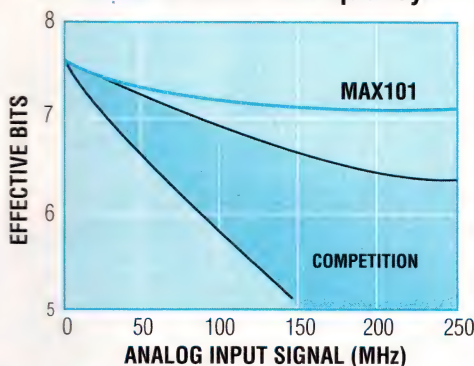
		CONV. RATE (MSPS)	INTERNAL T/H?	50Ω INPUT	EFFECTIVE BITS	SINAD (dB @ F <sub>IN</sub> )	INPUT BW (MHZ)	JITTER (pS)	INPUT CAP (pF)
Maxim	MAX101	500	Yes	Yes	7.1	43 @ 250MHz	1200	< 2	< 2
Maxim	MAX100	250	Yes	Yes	7.1	44 @ 125MHz	1200	< 2	< 2
Harris	HI1276	500	No	No	5.8	37 @ 100MHz	300	11	20
Sony	CXA1276K	500	No	No	6.4	40 @ 100MHz	500	5	16
SPT	SPT7750	500	No	No	6.3	40 @ 250MHz	900	2	15

## Evaluation System Speeds Prototyping and Design!

Fully-assembled kit provides a proven design and a high-speed pc-board layout, and greatly simplifies and speeds the process of evaluating the MAX100/MAX101. Order MAX100EVKIT or MAX101EVKIT.



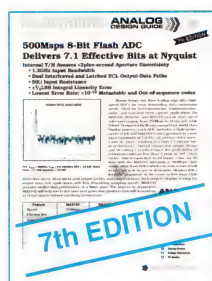
### Best ENOB vs. Frequency!



## FREE A/D Converter Design Guide—Sent Within 24 Hours!

CALL TOLL FREE 1-800-722-8266  
For a Design Guide

MasterCard® and Visa® are accepted for Evaluation Kits or small quantity orders.



**Distributed by Arrow, Bell, CAM RPC, Digi-Key, Elmo, Hamilton Hallmark, Nu Horizons, and Zeus.** Authorized Maxim Representatives: **AL**, EnVision; **AZ**, Techni Source Inc.; **CA**, Mesa, Infinity Sales, Inc.; **CO**, Component Sales; **CT**, Comp Rep Associates; **DE**, TAI Corporation; **FL**, Sales Engineering Concepts; **GA**, EnVision; **ID**, E.S. Chase; **IL**, Industrial Representatives, Inc.; **IN**, Technology Marketing Group; **IA**, JR Sales Engineering, Inc.; **KS**, Delltron; **LA**, Maxim Integrated Products, Inc.; **MD**, Micro-Comp, Inc.; **MA**, Comp Rep Associates; **MI**, Micro Tech Sales; **MN**, Mel Foster Technical Sales, Inc.; **MO**, Delltron; **MT**, E.S. Chase; **NE**, Delltron; **NH**, Comp Rep Associates; **NJ**, Parallax, TAI Corporation; **NM**, Techni Source Inc.; **NY**, Parallax, Reagan/Compar; **NC**, EnVision; **OH**, Lyons Corporation; **OK**, Maxim Integrated Products, Inc.; **OR**, E.S. Chase; **PA** (Pittsburgh area) Lyons Corporation, (Philadelphia area) TAI Corporation; **SC**, EnVision; **TX**, Maxim Integrated Products, Inc.; **UT**, Luscombe Engineering Co.; **VA**, Micro-Comp, Inc.; **WA**, E.S. Chase; **WI**, Industrial Representatives, Inc.

**Distributed in Canada by Arrow.** Authorized Maxim Representative in Canada: **Tech Trek.**

**Austria**, Allmos Electronics **Belgium**, Master Chips **Denmark**, arrow-exatec a/s **Finland**, Yleiselektronikka Oy, **France**, Maxim France, *France/Distributors*: Maxim France, ASAP **Germany**, Maxim GmbH *Germany/Distributors*: Maxim GmbH, Spezial Electronic KG **Ireland**, FMG Electronics **Italy**, Consystem S.r.l., *Italy/Distributor*: Esco Italiana Electronics Supply **Netherlands**, Koning En Hartman **Norway**, Berendsen Technology **Poland**, Uniprod, Ltd. **Portugal**, ADM Electronics, S.A. **Spain**, ADM Electronics S.A. **Sweden**, Egevo AB **Switzerland**, Laser & Electronics AG **Turkey**, Interex (U.S.A.) **U.K.**, Maxim Integrated Products (U.K.), Ltd., *U.K./Distributors*: Maxim Integrated Products (U.K.), Ltd., 2001 Electronic Components, HB Electronic

Maxim is a registered trademark of Maxim Integrated Products. © 1994 Maxim Integrated Products



**DSP chip provides telecommunications.** The TMS320C57 includes a C5x series DSP CPU, onboard memory to implement digital cellular telephone standards, and two intelligent peripherals—a buffered serial port and a host processor interface. A 3V process allows the device to run at a sustained throughput of 40 MIPS. The device offers a 5- $\mu$ A standby current, 32-kbyte ROM, and 7-kbyte RAM. The buffered serial port has a 2k-word buffer that

lowers the chip's overhead by eliminating the need to service real-time data interrupts from the system's A/D and D/A converters. A 128-pin TQFP costs \$33. **Texas Instruments Inc.**, Denver, CO. (800) 477-8924, ext 4500. **Circle No. 337**

**Interface IC connects four E1 channels.** The XR-T5794IJ contains four sets of CCITT G.703-compliant drivers and receivers, as well as associated diag-

nostic functions in a 68-pin PLCC package. With all transmitters on, the CMOS IC dissipates a maximum of 680 mW while sending all ones. You can power down each transmitter individually. Putting line-side bipolar outputs into high-impedance mode allows hot-swapping of line cards in systems. The receivers exceed G.703 cable-loss, interference-margin, and return-loss specifications. The IC also contains a fifth G.703 driver for channel monitoring and testing. \$29.71 (1000). **Exar Corp.**, San Jose, CA. (408) 434-6400. **Circle No. 338**

# HANSEN

## THE BEST THING GOING.



Hansen's precision motors have a reputation for efficient and productive service...even under the most demanding conditions.

**DC Motors.** High performance, long life and reasonable costs are characteristic of Hansen's DC motors, ideally suited for a number of applications.

**Stepper Motors.** Generate precision motion control with a Hansen stepper motor. A wide range of sizes (from 14 through 28) are utilized by our customers in the computer, office machine, medical equipment and automotive industries.

**Synchron Motors.** Hansen is a leader in synchronous motor technology and proudly supplies millions of synchronous motors annually for a variety of applications. Hansen's built-in quality and on-time delivery are supported by our customer service.

We will work with you to custom design the motor for your specific needs and match your application with the correct power source.

Tomorrow's ideas for today's technology...that's what Hansen is all about. Our motors are simply the best things going.



## Hansen Corporation

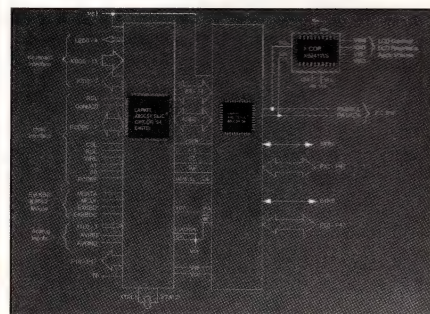
Hansen Corporation

A Minebea Group Company

P.O. Box 23 • Princeton, IN 47670-0023

Phone: 812-385-3415 • Fax: 812-385-3013

CIRCLE NO. 49



### Chip set integrates keyboard and power-management controller.

The LapKit provides keyboard control, display control, and power management of laptop computers. The device contains two of the company's E<sup>2</sup> devices and an Intel  $\mu$ C. The set is pre-programmed with a Phoenix Technology-compatible keyboard BIOS and an Intel 80C51SL  $\mu$ C, which features a keyboard controller for an 8042-based host interface. A 5V version costs \$22.33, and a 3V version costs \$25 (10,000). **Xicor Inc.**, Milpitas, CA. (408) 432-8888. **Circle No. 339**

### High-side driver turns $\mu$ P power on and off.

The L9820 drives inductive or resistive loads with one side connected to ground. An internal DMOS power-output transistor has an on-resistance of <800 m $\Omega$  and delivers 300 mA of continuous current and 1.5A peak current. A TTL-compatible input controls this output stage. Protection circuits guard the IC against damage from short circuits, junction overtemperature, and overvoltage conditions by disabling the output stage and informing the  $\mu$ P through a diagnostic output. The IC draws 4 mA in the on state and <300  $\mu$ A—typically 130  $\mu$ A—in the off state. In 8-pin DIPs and SOICs, the device costs around \$1 (OEM). **SGS-Thomson Microelectronics**, Lincoln, MA. (617) 259-0300. **Circle No. 340**



# HIGH-SPEED COMMUNICATIONS DESIGN SOLUTIONS

## An IDT Datacom Seminar

IDT's "High-Speed Communications Design Solutions" seminar provides information on the latest developments in datacom technologies and the innovative specialty memories, RISC microprocessors, and ATM-specific ICs that support them. This seminar is a must for engineering professionals involved in designing next-generation datacom systems or evaluating design options.

### SEMINAR OUTLINE

8:00 a.m. – 1:30 p.m., Lunch included

#### I. IDT ICs for Datacom Systems

#### II. ATM Systems

- Low-cost ATM interface card using a new SAR IC
- FIFOs and Multi-Port Memories in ATM switches

#### III. Routers

- An Ethernet-to-ATM router design
- Using Orion™ in a high-performance bridge/router
- A router for mixed voice and data traffic

#### IV. Portable Applications

- Components for PCMCIA cards
- A new highly integrated RISC CPU

### SEMINAR LOCATIONS

#### CALIFORNIA

Encino	October 27
Costa Mesa	October 26
San Diego	October 25
Santa Clara	October 20
Sunnyvale	October 25

#### COLORADO

Thornton	October 11
----------	------------

#### CONNECTICUT

Southbury	October 12
-----------	------------

#### ILLINOIS

Chicago	October 11
---------	------------

#### MARYLAND

Gaithersburg	October 4
--------------	-----------

#### MASSACHUSETTS

Chelmsford	October 6
Marlboro	October 13

#### MINNESOTA

Minneapolis	October 6
-------------	-----------

#### NEW JERSEY

Fairfield	October 5
-----------	-----------

#### NORTH CAROLINA

Raleigh	October 4
---------	-----------

#### TEXAS

Dallas	October 12
--------	------------

#### CANADA

Ottawa	October 5
--------	-----------

**RESERVE YOUR PLACE TODAY!**  
**CALL (800) 345-7015**  
and press "3" for FREE Seminar Registration



Integrated  
Device Technology, Inc.



# As fast as your microprocessors:



## Synchronous DRAMs from Fujitsu.

If you're using expensive SRAM cache memories because you can't find DRAMs to match your fastest microprocessors, your wait is over.

### High data transfer rates

Fujitsu has the DRAMs you've been waiting for: Synchronous DRAMs (SDRAMs) with speeds up to 100MHz and data transfer rates up to 100Mbytes/second. They operate synchronously with your processor clock, simplifying system control.

System design is simple, too. Fujitsu SDRAMs conform to JEDEC standards and they require only 3.3V power ( $\pm 0.3V$ ). This makes them the perfect choice for multimedia PCs — even low-voltage notebook models — and for most

workstations and high-performance systems.

### Replaces high-priced VRAMs

Fujitsu SDRAMs also make excellent replacements for VRAMs in many graphic systems. Less expensive than VRAMs, SDRAMs also eliminate the need for two data bus systems between the display controller and the RAM.

### World's first 64Mb SDRAMs

Our 16Mb SDRAMs are available now in production quantities, with 4Mb units available soon. Engineering samples of our 64Mb SDRAMs — the world's first — will be available by the end of the year. So why wait? For complete specifications, call Fujitsu today.



# FUJITSU

COMPUTERS, COMMUNICATIONS, MICROELECTRONICS

Headquarters (Japan): FUJITSU LIMITED (Electronic Devices International Operations Dept.) 1015, Kamikodanaka Nakahara-ku, Kawasaki 211, Japan Phone: (81-44) 754-3753 Fax: (81-44) 754-3332  
North America: FUJITSU MICROELECTRONICS, INC. 3545 North First Street San Jose, CA 95134-1804, USA. Phone: 408-922-9000 Fax: 408-432-9044, 9045  
Europe: FUJITSU MIKROELEKTRONIK GMBH Am Siebenstein 6-10, 63303 Dreieich-Buchschlag, Germany Phone: (06103) 690-0 Telex: 411963 fmg d Fax: (06103) 690-122



**FREE INFO, FREE POSTAGE**

Use our postage-paid reader-service cards to get more information on any of these products.

### Graphical design tools simplify state-machine and data-path design.

Enter your state machine and data-path designs graphically using ViewFSM and ViewDatapath. The tools generate VHDL code for use with logic-synthesis tools. Prices for ViewFSM and ViewDatapath start at \$10,000 and \$1600, respectively. **Viewlogic Systems Inc.**, Marlboro, MA. (508) 480-0881.

**Circle No. 427**

### Low-cost tool lets you draw and analyze timing diagrams.

Timing Diagrammer lets you draw and analyze timing diagrams for violations. You can specify delays that force relative transition times between sig-

nals, setup-and-hold times that monitor the time between two signal transitions, and create spreadsheets for editing timing parameters. The timing parameters can be mathematical expressions containing variables. The tool runs on PCs under Windows 3.1 and costs \$249.99. **SynaptiCAD**, Blacksburg, VA. (703) 953-3390.

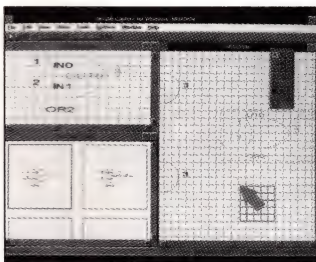
**Circle No. 428**

### Optimizer speeds fixed-point DSP designs.

The upgraded version of Signal Processing WorkSystem adds the Fixed Point Optimizer option. The option determines the number of bits needed in a fixed-point word to meet a system specification, such as S/N ratio. You can also start a design with floating-point behavioral design and generate the fixed-point behavioral design. The optimizer works

with virtually any design, including time-varying, multirate, and nonlinear systems in wireless and multimedia applications. The Fixed Point Optimizer will be available in the third quarter, and prices start at \$20,000. **Alta Group**, Foster City, CA. (415) 574-5800.

**Circle No. 429**



### PC-based electronic design automation tool supplier moves to Windows.

OrCAD is making all its design tools available on Design Desktop for Windows. Capture for Windows, the company's schematic-

capture tool, will be available by the end of November. The company expects the remainder of its tools to be available under Windows by year-end. Capture for Windows will cost \$995, with discounts available for existing customers. **OrCAD**, Beaverton, OR. (503) 671-9500.

**Circle No. 430**

### FPGA design kit for Actel units improves performance of synthesized designs.

This field-programmable gate-array (FPGA) design kit supports Synopsys' FPGA Compiler 3.1, DesignWare microcells, and VHDL System Simulator. Using the kit with FPGA Compiler 3.1 provides a performance improvement of up to 80%, the company claims. A graphics coprocessor design, including datapath and arithmetic functions, operates at 43 MHz, a 78% improvement over the

MESSE MÜNCHEN  
INTERNATIONAL



# electronica 94

# The Standard

electronica 94 is the international electronics forum for the  
sectors  
• Components  
• Assemblies  
• Electronics Design  
• Measurement Technology and Test Systems

**Munich, November 8-12, 1994**  
**16th International Trade Fair for Components and Assemblies in Electronics**

For developers, decision-makers and users,  
electronica 94 is a vital catalyst for devel-  
opments in science and technology.  
Further information from:  
Messe München GmbH, Messagelände,  
D-80325 München,  
Tel. (+49 89) 5107-0,  
Fax (+49 89) 5107-312



previous design kit and compiler versions. The design kit costs \$4995 and will be available in September. **Actel Corp.**, Sunnyvale, CA. (408) 739-1010.

**Circle No. 431**

**Mixed-signal simulator offers native analog and VHDL simulation.** The VHDeLDO analog and digital simulator comprises the company's HDL-D VHDL simulator, and HDL-A, a

VHDL-based analog simulator. The simulator lets you use behavioral models for both analog and digital systems components. Prices for VHDeLDO start at \$35,000. **Anacad EES**, Milpitas, CA. (408) 954-0600.

**Circle No. 432**

**Active-filter design tool runs on PCs.** The AFDPLUS design tool helps you design lowpass, highpass, bandpass, band-reject, and allpass filters.

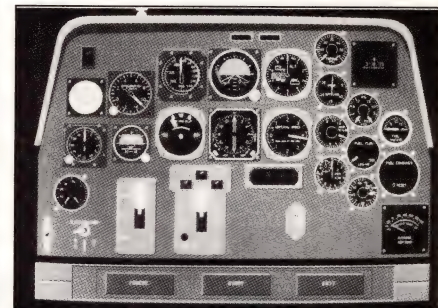
The tool provides mathematical-filter characteristics including Butterworth, Chebychev, Elliptic, Bessel, and Gaussian, plus more exotic behaviors, such as Papoulis and Catenary responses. The software also provides PLL analysis. AFDPLUS 3.0 costs \$995. **Webb Laboratories**, Brookfield, WI. (414) 367-6825.

**Circle No. 433**

**Tool links corporate component database with schematic capture.**

PROdatabook is a PC-based component data-entry and -verification tool that links schematic capture with component databases. The tool costs \$1495 for a single user and \$14,995 for a site license. **Viewlogic Systems Inc.**, Marlboro, MA. (508) 480-0881.

**Circle No. 434**



**Prototype real-time graphical human-machine interfaces.**

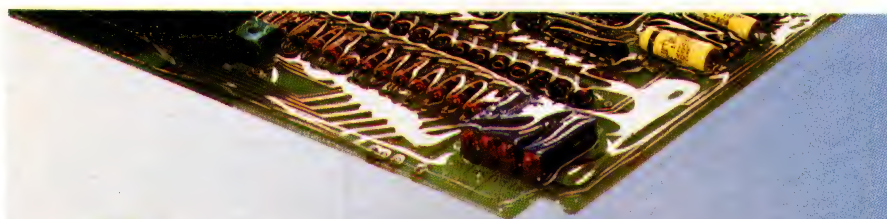
VAPS 3.1 provides a set of tools to help you build real-time graphical human-machine interfaces. In addition to helping you create a prototype, the VAPS C code generator translates the graphical prototypes, including animation properties, interactive behavior, and connections into executable C code. You can integrate the generated C code with real-time kernels. VAPS runs on workstations, and prices start at \$16,500. The company plans to introduce a version for Windows in the fall. **Virtual Prototypes Inc.**, Montreal, PQ. (514) 341-3874.

**Circle No. 435**

**Specify and analyze pc-board and multichip-module layout constraints.**

EngineerView lets you define and analyze topology-based electrical rules early in a design. In addition to setting up rules that constrain the physical layout, you can also perform initial placement of critical components on the board using an interactive timing-driven placement capability. EngineerView is scheduled for fall availability and costs \$49,500. **Mentor Graphics**, Wilsonville, OR. (503) 685-8000.

**Circle No. 436**



**ECCOCOAT®**  
Conformal  
Coatings.

All the  
performance  
you need without  
all the solvents.

Everything you want in a one-component conformal coating is in the complete line of ECCOCOAT® products from Grace Specialty Polymers.

- Solvent free for low VOCs
- Easy to apply with dip, spray, flood or brush methods
- Complete line of chemistries and cure options
- MIL Spec listed and UL rated
- Reduced material and handling costs

Plus, ECCOCOAT UV-7900 is the only UV coating in the industry with a reliable secondary moisture cure — providing excellent cure under every component.

All you need to do now is call Grace Specialty Polymers — the company with a global perspective.



**GRACE Specialty Polymers**

North America  
Woburn, MA  
(800) 832-4929

Europe  
Westerlo, Belgium  
+32-(0)14-57 56 11

Asia-Pacific  
Atsugi, Japan  
(81) 0462-25-8800

©1994, W.R. GRACE & Co. - Conn.

**CIRCLE NO. 114**





# WELCOME TO THE SUBMICRON WORLD OF COMPASS DESIGN

One million gates. Four million transistors.  
All in 0.35 $\mu$  technology.

Sound like the future? Hardly. That's the kind of design that companies worldwide are achieving with COMPASS' new generation of IC design tools.

Only COMPASS provides a seamless graphical specification and synthesis environment that integrates logic design, physical design, libraries and library development tools. Others make this claim but it's no secret they built their product line by acquiring technologies to fill in design "holes."

COMPASS tools were built from the top down. You get everything you need from one company, at one time. And all COMPASS tools are designed to work with the foundry of your choice.

Say good-bye to yesterday's mix-and-match design tools, endless hours of integration and empty promises. Say hello to tightly integrated tools that speed you from concept through synthesis, layout, verification and silicon. Break through today's design barriers – into the future of submicron design.

Call 1-800-433-4880 for more information on COMPASS design tools.  
The shape of things to come.

**COMPASS**   
Design Automation

**CIRCLE NO. 70**  
**Synthesis to Silicon**  
COMPASS Design Automation,  
1865 Lundy Avenue, San Jose, CA 95131  
© 1994 COMPASS Design Automation, Inc.  
The COMPASS logo is a registered trademark  
of COMPASS Design Automation, Inc.



**FREE INFO, FREE POSTAGE**

Use our postage-paid reader-service cards to get more information on any of these products.

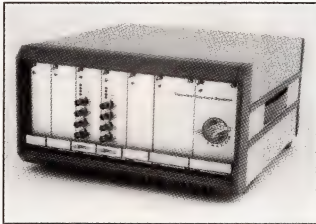
**Windows-based software simplifies acquiring data from meters and counters.** The 34812A BenchLink/Meter package lets you transfer data from HP DMMs and counters to your PC without writing code. The software transforms the 34401A DMM and the 53131A, 53132A, and 53181A counters into single-channel data-acquisition systems. \$150. Hewlett-Packard Co, Santa Clara, CA. (800) 452-4844.

**Circle No. 352**

**\$395 data-acquisition boards take 100k samples/sec.** The two-thirds-length PCI-20428W-1 and -2, which plug into the 8-bit ISA bus, both offer 16 input channels, 12-bit resolution,

a programmable-gain amplifier, two DAC outputs, eight TTL inputs, eight TTL outputs, a counter/timer, and two-channel DMA. The -1 version offers gains of one, 10, and 100; the -2 version offers gains of one, two, four, and eight. Intelligent Instrumentation, Tucson, AZ. (602) 623-9801.

**Circle No. 353**



**Transient data recorder captures 1M samples/channel at up to 2M samples/sec.** The modular Falcon system works with PCs running MS Windows. The vendor supplies the system with or without the PC. You

can choose among 12-bit ADC modules: A module that takes 2M samples/sec/channel contains four simultaneous-sampling ADCs. One type of 25k-sample/sec/channel unit has 32 simultaneous-sampling ADCs; a second has 64. Mainframes accept up to eight modules; systems can include several mainframes. The unit captures pretrigger or post-trigger data. Triggering is under control of an external timebase or an internal programmable crystal clock. Without a PC, an eight-channel, 2M-sample/sec system costs \$16,250; four-channel, 2M-sample/sec modules cost \$4445. Sunny-side Systems Inc, Tucson, AZ. (602) 742-0755.

**Circle No. 354**

**VXIbus slot-0 controller ships with MS-DOS V6.2.** The VXI-5543D (\$5250) is a two-slot, C-size VXIbus

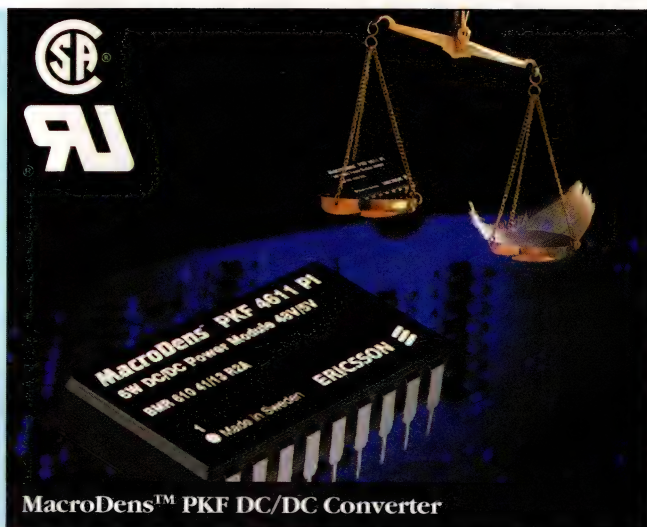
module based on an i386SL  $\mu$ P. The module includes three RS-232C/RS-485 ports (two of which operate to 115.2 kbps), a bidirectional printer port, a VGA video port, a bus-mouse port, a 3 $\frac{1}{2}$ -in. floppy-disk drive, a 240-Mbyte hard-disk drive, and a 1-Mbyte solid-state disk for program storage. The standard 4-Mbyte RAM expands to 10 Mbytes. Besides MS-DOS, software installed on the hard disk includes an interactive system monitor, ANSI-compatible C-language driver libraries, and sample programs. ICS Electronics Corp, Milpitas, CA. (408) 263-5500.

**Circle No. 355**

**6U VMEbus board houses 16 delta-sigma ADCs, 16 DACs, and eight C40 communications ports.** The Model 4625 divides its inputs and outputs into four groups, each of which has its

# The world's most advanced DC/DC converter?

- Remarkably small 18 pin DIL package - just 48mm x 24mm x 8mm (1.89" x 0.94" x 0.31")
- 3 - 7 watts
- 38 to 72 Vdc input range
- A choice of 2, 3.3, 5 or 12 Vdc outputs
- 1,500 Vdc isolation
- MTBF more than 400 years
- A weight range of only 15-20 grams (0.52 - 0.71 oz.)
- Suitable for automatic placement - through hole or surface mount versions



**Ericsson Components, Inc.**  
403 International Parkway, Richardson, TX 75081  
Tel: (214) 997-6561 or (214) 669-9900 Fax: (214) 680-1059

**ERICSSON**

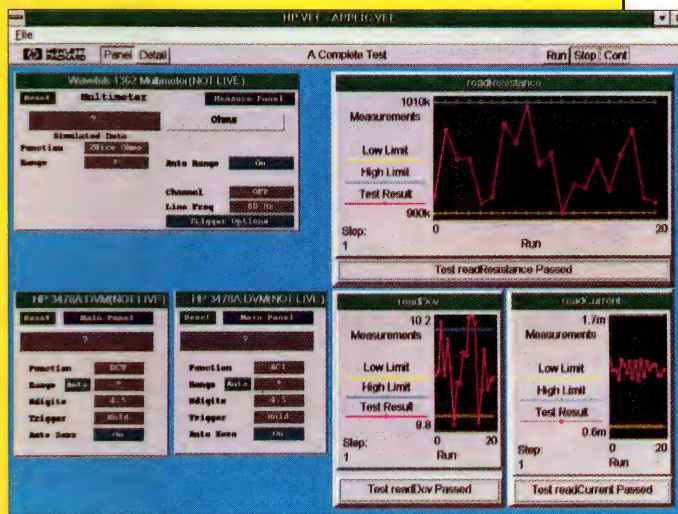
**CIRCLE NO. 78**



# When it is time

to switch to graphical  
test programming,  
make sure the  
language you  
choose won't  
force you

to  
change  
everything you've done  
in the past.



In a world where the only thing constant is change, it's good to know there are certain things you can rely on.

Like test development.

Use HP VEE, and enjoy the simplicity and ease-of-use you can only get from graphical programming. Sure, you'll keep the power your code-based language delivers, but you'll program that power using handy icons, instead of thousands of lines of code.

We poured every gram of our 50 years of test experience into HP VEE. The

result is a development language in which instrument control is complete, robust, totally logical, and without any limitations.

Even the *type* of instrument you can control is without limitations — from an off-the-shelf vendor-supplied instrument to a device you designed.

Another aspect of HP VEE you'll find liberating is that your existing code is directly compatible, so you won't need to rewrite routines. You'll also appreciate how much faster and easier it is

to develop programs that are incredibly simple to use — even if you've never created test programs before.

That's HP VEE: powerful, logical, open, and easy to use. And the most comfortable way to make a change.

For more information on HP VEE, contact one of the numbers listed below

There is a better way.



HEWLETT®  
PACKARD

France (1) 69-82-65-00 Germany (06172) 16-1634 Italy (02) 9212-2241 Netherlands (020) 547-6669  
Spain 900 123-123 Sweden (08) 444-2000 Switzerland (1) 735 7111 U.K. (0344) 366666

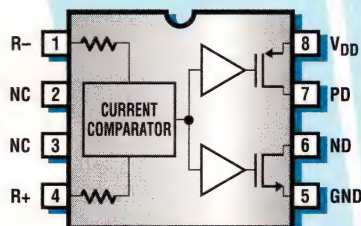


# Power Control Made Easy!

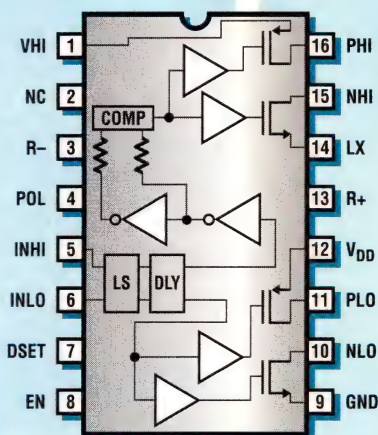
**DESIGN ADVANTAGE:** • Solves Below Ground Ringing  
• No Start-Up Uncertainty • No False Triggering

## The Family of 1 MHz MOSFET and IGBT Drivers

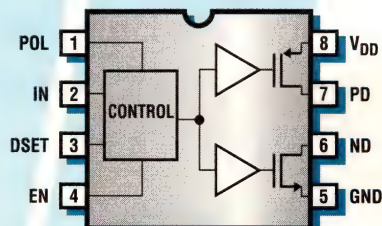
### EL7501C High Side Driver



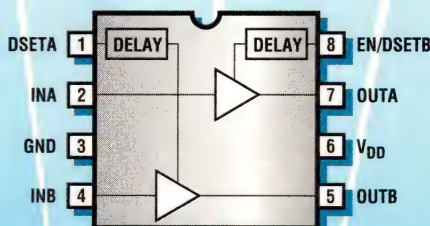
### EL7761C Half Bridge Driver



### EL7861C Single Delay Driver



### EL7961C/7971C/7981C EL7962C/7972C/7982C Dual Delay Drivers



#### FEATURES

- Dielectrically Isolated 100V High Side
- Programmable Time Delay
- Direct Coupled to High and Low Side
- Noise Blanking Circuitry
- Isolated Drains for Versatile Output Connection
- Break-Before-Make Switching
- Call Us for Many More Features

#### APPLICATIONS

- Uninterruptible Power Supplies
- DC/DC Converters
- Switch Mode Power Supplies
- Resonant Switching Supplies
- Pricing Begins at \$2.38, P-DIP, 1,000-unit volumes (Also Available in SO)

CALL FOR OUR FULL-LINE  
CMOS POWER PRODUCT  
DATABOOK, NOW AVAILABLE

**élantec**

HIGH PERFORMANCE ANALOG INTEGRATED CIRCUITS

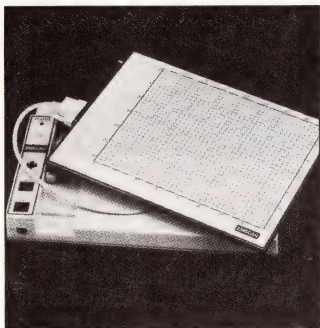
ELANTEC, INC. ■ 1996 Tarob Court ■ Milpitas, CA 95035 ■ (408) 945-1323 ■ (800) 333-6314 ■ FAX (408) 945-9305

Authorized Distributors: Marshall Industries ■ Nu Horizons ■ Insight Electronics

FOR SAMPLES CALL  
(800) 333-6314 ext 311  
For Literature Only - ext 234



own sample-rate generator whose frequency you can set from 4 to 48 kHz with 32-bit resolution. Each group can operate in A/D, D/A, or combination modes and can use one or two C40 ports. The ADCs feature amplifiers whose gain is programmable from 0 to 22.5 dB in 1.5-dB steps. The DACs include attenuators programmable from 0 to 94.5 dB in 1.5-dB steps. The ADCs operate as 16-bit linear devices or as 8-bit A- or  $\mu$ -law encoders. \$4995; delivery four to six weeks, ARO. **Pentek Inc.**, Norwood, NJ. (201) 767-7100. **Circle No. 356**



**Scanner maps pc boards' EMI emissions and susceptibility.** EMSCAN uses spectral and spatial scans to locate and quantify 10- to 750-MHz near-field emission sources on boards as large as 9.6x12 in. The system also performs susceptibility testing by mapping the flow of injected RF currents. Besides the scanner, which contains 1280 current probes spaced 0.3 in. apart, the system includes a power supply, an IEEE-488 interface, and Windows-based software, which controls scanning, data storage, and data retrieval, and aids in evaluating test results. \$47,000; delivery, six weeks, ARO. **Amplifier Research**, Souderton, PA. (215) 723-8181. **Circle No. 357**

**EISA bus IEEE-488.2 controller transfers data at over 7.5 Mbytes/sec.** The EISA-GPIB board, which is based on the vendor's

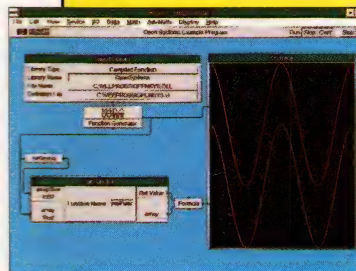
TNT4882C controller ASIC, supports the vendor's HS488 protocol. Using the protocol, the board can transfer data to or from devices on the bus at speeds >7.5 Mbytes/sec. The vendor's NI-488.2 driver software package for MS-DOS and Windows accompanies the board. \$595. **National Instruments Corp.**, Austin, TX. (512) 794-0100. **Circle No. 360**

**PCMCIA card diagnoses faults in PC-card interfaces.** With the BGM64, which plugs into a PCMCIA slot, you can wrap the data and address buses through a PCMCIA interface and check them for opens and shorts. Host software allows testing of all 16 bits in an emulated 64-Mbyte address space. Because no 64-Mbyte solid-state memory cards exist, you can easily overlook testing the upper reaches of the address space. The card also tests the power supplies to make sure that they can handle the loads they should be able to drive. \$249; developers kit, \$4500. **Boca Technology Group**, Boca Raton, FL. (407) 750-1528. **Circle No. 358**

**Tester takes 3 sec/Mbyte to verify 100% of RAM-module function seven ways.** Sigma LC is a low-cost version of Sigma 2, which the vendor claims is the most popular test system among US third-party SIMM manufacturers. The Sigma LC can test four 30-pin memory modules simultaneously. This configuration mimics that of most PCs. According to the vendor, there is no reliable way to determine which of the four SIMMs in a PC is defective. By placing all four SIMMs in the tester, you can determine which one is bad. \$1395. **Darkhorse Systems Inc.**, Austin, TX. (512) 258-5721. **Circle No. 359**

It seems  
like  
**half**  
your life is spent  
developing test  
programs.

But then, that's  
**the cost**  
of using the wrong  
programming  
language.



With HP VEE  
50% off, the  
transition to  
graphical  
programming  
is even  
easier.

Now that you've seen what HP VEE can do, just wait'll you see what it costs

Because now you can get the Windows version for half-price, and the HP-UX and SUN versions are also offered to you with 50% discount. Imagine, today's most powerful, intuitive GPL at a price that's comparable to text-based languages.

But hurry. This offer expires on December 31, 1994. Order before then and we'll include a free 6-month support contract for software updates, including our next upgrade coming soon.

**Call one of the numbers listed below to order HP VEE.**

**There is a better way.**



France (1) 69-82-65-00 Germany (06172) 16-1634 Italy (02) 9212-2241  
Netherlands (020) 547-6669 Spain 900 123-123 Sweden (08) 444-2000  
Switzerland (1) 735 7111 U.K. (0344) 366666



**FREE INFO, FREE POSTAGE**

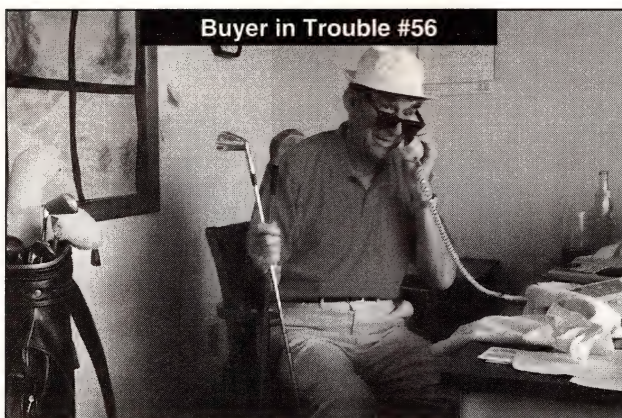
Use our postage-paid reader-service cards to get more information on any of these products.

**Ada comes to Pentium.** A validated Ada development system targeting the Pentium processor is now available. The system includes a compiler and a Motif-based symbolic debugger. It is available hosted on VAX/VMS, SPARC SunOS,

and Solaris workstations. Its output format is OMF-compatible, allowing use with third-party tools. Future versions of the software will include optimization for the Pentium's dual-instruction pipeline. **DCC-I Inc.**, Phoenix, AZ. (602) 275-7172. **Circle No. 437**

**STD card cage offers ISA slots.** The ZT 211 series of STD-32 card cages provides 18 or 21 card slots for STD 32

boards and two card slots for ISA-bus PC add-in cards. The ISA cards fit into a protected enclosure at the rear of the cage and operate as if they were STD I/O cards. The cages also feature front-removable ac- and dc-power-supply modules, forced-air cooling, and provisions for either table or rack mounting. The cages meet IEEE specification P1156 for shock and vibration. Prices start at \$1100. **Ziatech Corp.**, San Luis Obispo, CA. (805) 541-0488. **Circle No. 438**



Buyer in Trouble #56

## Teeing Off the Engineers

"What do you mean they don't work? Well, you shoulda said something about volts before this. I know Prem custom designs power transformers, but the other guys had a sale on 15 volt units. (CLICK!) Hello...Hello...Picky engineers!"

*I really shoulda called Prem.*

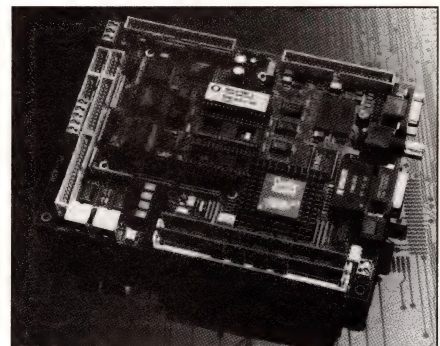
**You oughta call Prem!"**



# PREM®

**Where Quality Really Counts!**

For Prem's new catalog or additional product information, call or write  
Prem Magnetics, Inc.  
3521 North Chapel Hill Road, McHenry, IL 60050.  
Phone: 815-385-2700. FAX: 815-385-8578.



**Embedded PC meets file server needs.** With its built-in 486 processor, 32-Mbyte memory, Novell-compatible Ethernet interfaces, and three solid-state disks, the PC-450 can perform all the tasks of an office file server. The 6x8-in. board also offers an SVGA-display interface capable of driving color-LCDs and interfaces for keyboard, touchscreen, CD-ROM, and optical drives. The board provides DOS 6.0 in ROM, IDE and SCSI-2 ports, and an optional fiber-optic interface. Prices start at \$2700. **Octagon Systems**, Westminster, CO. (303) 430-1500. **Circle No. 439**

**PowerPC joins military VME.** The CPU-601 is a single-width 6U VME board based on a 50-MHz PowerPC 601 processor. The board is compatible with VME64, IEEE 1014, and IEEE1101.2 specifications and is available in full MIL-SPEC or industrial versions. It includes as much as 4 Mbytes of flash memory, 2 kbytes of serial EEPROM, and two serial ports. The board comes with built-in test and monitor firmware. Pricing starts at \$6000. **Radstone Technology Corp.**, Montvale, NJ. (201) 368-2738. **Circle No. 440**

**Pentium PCI-bus comes to Multibus II.** Based on the 90-MHz Pentium Processor, the SBPC5090 board provides a high-performance, PC-compatible Multibus II board. The board





# If You're Looking For Product Acceptance In North America, UL Holds The Key.

THE BIG NEWS TODAY IS THAT UL IS ACCEPTED ALL ACROSS CANADA. AND WITH THE SIGNING OF A COOPERATIVE ASSISTANCE AGREEMENT WITH THE ASOCIACION NACIONAL DE NORMALIZACION Y CERTIFICACION DEL SECTOR ELECTRICO (ANCE), THE FIRST INDEPENDENT STANDARDS AND PRODUCT CERTIFICATION ORGANIZATION ACCREDITED BY THE MEXICAN GOVERNMENT — UL IS THE FIRST ORGANIZATION OF ITS KIND TO OFFER MANUFACTURERS ACCESS TO CERTIFICATIONS FOR ALL OF NORTH AMERICA.

AND SINCE UL PROVIDES CERTIFICATION THAT ALLOWS IMMEDIATE ACCEPTANCE ACROSS THE ENTIRE UNITED STATES, SAVING TIME AND MONEY TO GAIN ACCEPTANCE ACROSS NORTH AMERICA HAS NEVER BEEN EASIER.

IN FACT, NO OTHER SAFETY CERTIFICATION SERVICE CAN DELIVER WHAT UL PROVIDES. AND BECAUSE WE OPERATE AS A NOT-FOR-PROFIT ORGANIZATION, YOU CAN BE ASSURED THAT OUR PRIMARY OBJECTIVE REMAINS SAFETY.

SO IF YOU'RE LOOKING FOR ONE SOURCE THAT NOT ONLY HANDLES PRODUCT SAFETY CERTIFICATION ACROSS THE UNITED STATES, BUT ALSO FACILITATES EXPANDING YOUR PRODUCTS' ACCEPTANCE BEYOND THE BORDERS, WE CAN HAND YOU THE KEY.

**U.S. HEADQUARTERS:** BARBARA OLDS  
PHONE: 708-272-8800, EXT. 43319  
FAX: 708-272-9562

**CANADA:** JOHN WOODS  
PHONE: 613-742-6965  
FAX: 613-742-6965

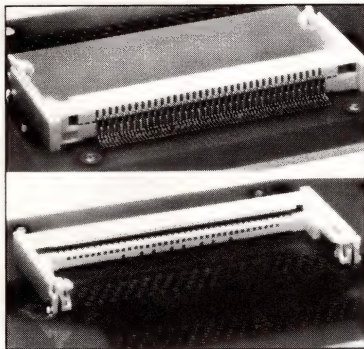


**Underwriters Laboratories Inc.®**

ACCREDITED AS A CERTIFICATION ORGANIZATION BY THE STANDARDS COUNCIL OF CANADA.



## DOUBLE DENSITY MEMORY MODULE SOCKET WITH 72 POSITIONS

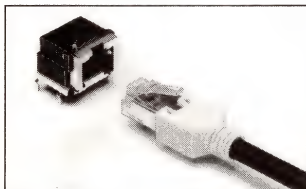


Hirose is offering the SX1 series of "double density" socket connectors for 72-position Small Outline SIMM (single in-line memory module). By offering .025" (0.635mm) versus .050" (1.27mm) lead termination spacing, Hirose's double density (double-sided) socket allows the module board to achieve a higher density while reducing the module board to half the size of existing 72-position boards. The SIMM, itself, actually increases the memory capacity of the module from 4Mb (DRAM IC) TO 16Mb high density IC. The right angle socket connector has a low profile of less than 6mm (0.236") when the module board is locked in, including the height of the module. Contacts are right angle SMT with spacing of 0.635mm. Applications for the SX1 series are personal computers, office automation equipment, medical equipment, factory automation equipment, game products, general purpose computers and measuring equipment.

For more information, contact **Hirose Electric (U.S.A.), Inc.**, (805) 522-7958 or fax (805) 522-3217. For catalog information via fax: 800-879-8071. Ask for #5017.

**CIRCLE NO. 26**

## TM CONNECTORS FOR LAN, ISDN AND PC's WITH EMI SHIELDING



Hirose is offering a new line TM11 modular connectors with EMI shielding protection. The one-piece construction of the shell and clamp provide excellent EMI protection for ISDN terminals and personal computers, LAN boards and for the datacom industry. In order to protect equipment circuitry, the jack is built to allow the shielding to easily engage and lock first upon mating. A metal shell offers ESD protection and a plastic cover is provided for enhanced aesthetics. Available in either 6 or 8-positions, the TM11 connector is a popular replacement for the industry standard RJ45 and is now being widely accepted for building wiring applications.

For further information, contact **Hirose Electric (U.S.A.), Inc.**, (805) 522-7958 or FAX (805) 522-3217. For catalog information via fax: 800-879-8071. Ask for #3002.

**CIRCLE NO. 29**

## HALF-PITCH, TWO-PIECE CONNECTORS FOR SMT APPLICATIONS



Hirose is delivering the FX4 series of half-pitch (1.27mm, 0.050") surface mount connectors with stacking heights of 5 to 11mm between PCB's. Hirose also

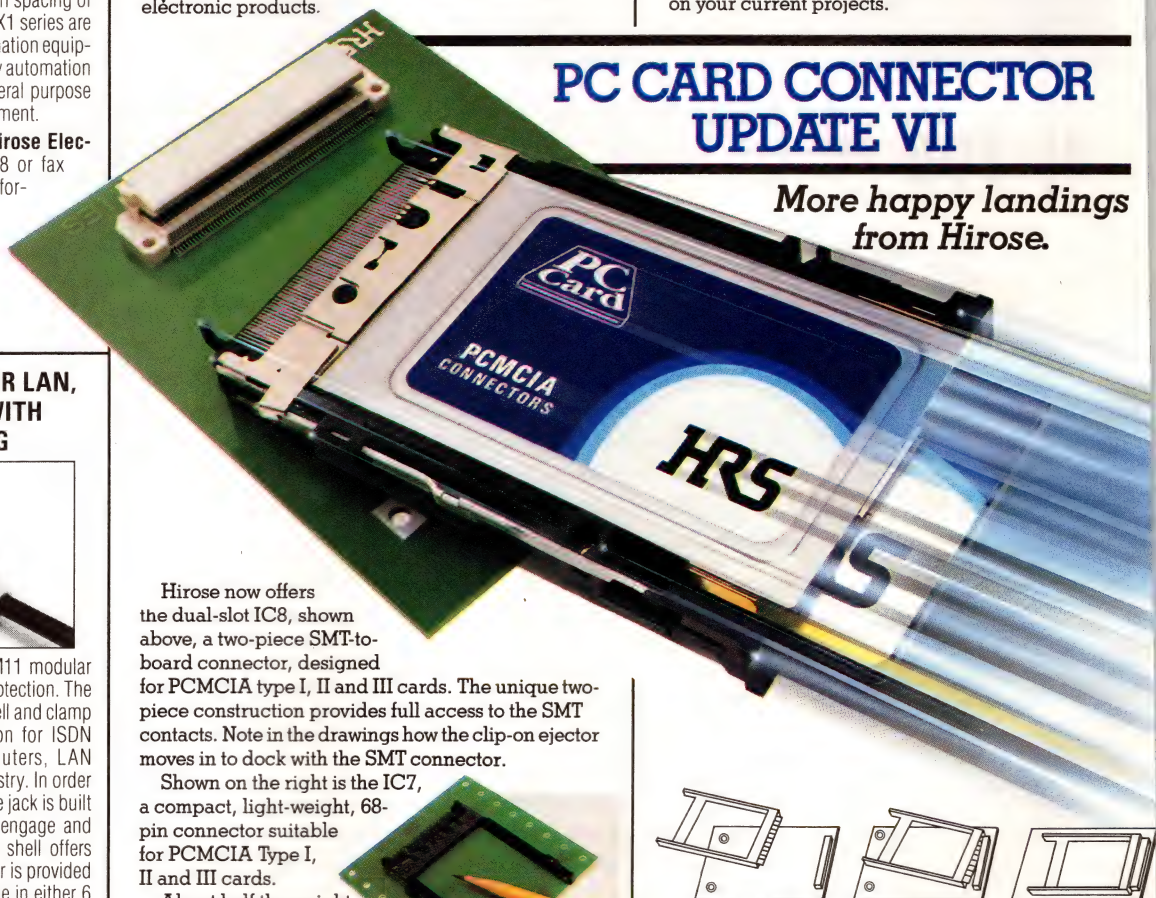
offers through hole styles which are available with stacking heights of 5 to 11mm. As a result of the continuing trend to miniaturization of equipment, Hirose designed the FX4 series of SMT connectors to satisfy the needs of smaller component sizes. While stacking heights can be set at 6, 6.5, 7, 7.5, 8, 8.5, 9, 10 and 11mm, contact design features low insertion and extraction forces. Available in 20, 32, 40, 52, 60, 68 and 80-positions, the FX4 SMT series is ideal for computers, peripherals, terminal equipment and a wide variety of office automation equipment.

For further information, contact **Hirose Electric (U.S.A.), Inc.**, (805) 522-7958 or FAX (805) 522-3217. For catalog information via fax: 800-879-8071. Ask for #5009.

**CIRCLE NO. 27**

**J**ust when you thought you have seen everything in PC card connector technology, Hirose presents more surprises.

For Hirose customers, though, these compact solutions are expected. Because every day, Hirose helps design engineers package compact memory and I/O capability into sophisticated, compact electronic products.



Hirose now offers the dual-slot IC8, shown above, a two-piece SMT-to-board connector, designed for PCMCIA type I, II and III cards. The unique two-piece construction provides full access to the SMT contacts. Note in the drawings how the clip-on ejector moves in to dock with the SMT connector.

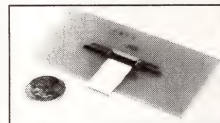
Shown on the right is the IC7, a compact, light-weight, 68-pin connector suitable for PCMCIA Type I, II and III cards.

About half the weight and substantially smaller and thinner than previous product, it is suitable for SMT or through-hole mounting, standard or reverse placement under the PCB and with options of left or right hand eject buttons. The choice is yours.

**Circle No. 30**

**See us at Wescon in booths 3493-95**

## "FLIP-LOCK" SMT/ZIF TYPE FLEXIBLE PCB CONNECTOR



Hirose is producing the FH12 series of miniature connectors for FPC/FFC use. These newly developed connectors use a "flip-lock" concept and can

be used with surface mount technology to prevent problems associated with slide-lock systems. The FH12 series connectors have spacing of 0.5mm (0.020") and are suited to high density mounting, with a mounting height of only 2mm. The new connector has also been reduced by 1.7mm in length compared to earlier Hirose products. It is available with 10, 15, 20, 24, 30, 33, 36, 40, 45 and 50-positions. Hirose's one-touch ZIF (zero insertion force) technology offers labor-savings, even with multiple contacts. Ideal for LCD-related uses, as well as portable telephones, CD-ROM and other miniature products.

For further information, contact **Hirose Electric (U.S.A.), Inc.**, (805) 522-7958 or FAX (805) 522-3217. For catalog information via fax: 800-879-8071. Ask for #5018.

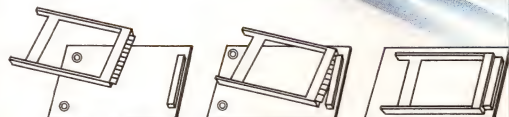
**CIRCLE NO. 28**

If you are looking for alternative designs, consider the IC6 series of dual-slot PC card header connectors. These through-hole connectors are available in high-temp or value-engineered versions, and will take Type I, II and III cards.

Learn how Hirose can make your PCMCIA card interconnects, with ESD and EMI protection, work on your current projects.

## PC CARD CONNECTOR UPDATE VII

*More happy landings  
from Hirose.*



Shown is the IC8, a dual-slot, two-piece, SMT-to-board connector. The SMT portion provides full access for visual inspection of solder terminations.

**HRS**

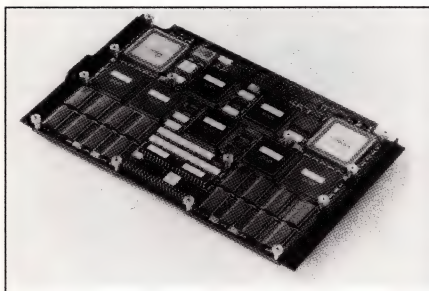
**Hirose Electric (U.S.A.), Inc.**  
2688 Westhills Court, Simi Valley, CA  
93065-6235 • (805) 522-7958  
FAX (805) 522-3217. For instant fax

catalog information: 1-800-879-8071. On the IC6, ask for #8005. On the IC7, ask for #8008, on the IC8, ask for #8009.



includes both a PC BIOS and Multibus system software in flash memory, allowing use of off-the-shelf software such as DOS or PC Unix. The board also incorporates a PCI-to-Multibus bridge ASIC that allows PCI peripherals to pass data directly to the bus. IDE, Ethernet, and SCSI-2 interfaces on the PCI bus come standard with the board. An SVGA controller is available as an optional add-on module. Board memory can be as large as 128 Mbytes, and board memory is added using standard SIMMs. Software support for the board includes iRMX, Windows, and Univex UnixWare. Prices start at \$6495. Intel Corp., Santa Clara, CA. (800) 438-4769.

**Circle No. 441**



**Military vector processor provides 160 Mflops.** Using dual i860 processors sharing as much as 16 Mbytes of memory, the VSP-1 vector signal processor provides 160 Mflops of sustained compute power in a single VME slot. Each processor has an independent datapath to memory through a crossbar switch. A separate i960 processor handles communications and data transfers to the VME bus. The board comes with a programmer's tool kit and is supported by Wind River's VxWorks. The VSP-1 is available in full MIL-SPEC and ruggedized commercial versions with prices starting at \$23,530. Radstone Technology Corp., Montvale, NJ. (201) 391-2700. **Circle No. 442**

**Real-time kernel runs on PA-RISC CPU.** A version of C Executive, a ROMable multitasking system operating kernel, is now available for the PA-RISC architecture. The version is designed to run on the Oki OP50N embedded  $\mu$ P version of PA-RISC with the Densan DVE-OP50N/12 development board as the target. The development tools include a Hewlett-Packard ANSI-C compiler. In addition to the real-time kernel, C Executive offers an optional file system, a debugger, and a TCP/IP communications package. JMI Software Systems Inc., Spring House, PA. (215) 628-0840. **Circle No. 443**

**PowerPC card takes PCI.** Offering the PowerPC 603 processor as its core, the Power\*3 board provides a VME64 bus interface and a PCI local mezzanine bus. The board accepts 512 kbytes of EPROM for holding the operating system, has as much as 128 Mbytes of DRAM, and runs at either 66 or 80 MHz. The VxWorks and RTMX operating systems are available for the board, with Solaris, OS-9000, pSOS, and LynxOS available later in the year. Price is <\$4000. VI Computer Corp., Encinitas, CA. (619) 632-5823. **Circle No. 444**

**Modular kernel supports standard tools.** The PXROM+ modular real-time kernel works with industry-standard compilers, debuggers, and in-circuit emulators. The basic kernel provides multitasking, events, semaphores, and intertask communications. Installable system modules include RAM disk, SCSI support, and flat- or hierarchical-file systems. The kernel will be available first for use with Microtec Research's Xray development software. License cost is \$4000 for the first seat, additional seats cost as little as \$1500, and annual maintenance fees are 20%. Eyring Corp., Midvale, UT. (801) 561-1111. **Circle No. 445**

**Software migrates Unix GUIs to Windows.** Part of a family of client/server tools for building graphical user interfaces (GUIs), the TeleUse/Win software module allows cross development between Unix and Windows. The module runs under Unix and generates native Microsoft Foundation Class (MFC) C++ code. The code can then run under Windows-based Visual C++. The module automatically maps Motif widgets and their resources to objects. A single license costs \$1890. Alslys Inc., San Diego, CA. (619) 457-2700. **Circle No. 446**

**VME boards ride the AutoBahn.** The VM42A is a 3U VME board that contains the AutoBahn Spanceiver. The Spanceiver provides a data transfer rate of 200 Mbytes/sec and 128 kbytes of dual-port SRAM buffer for linking CPUs together. The board contains a 50-MHz 68040 processor and a 25-MHz 68EN360 communications controller. It also offers a CXM mezzanine bus for Ethernet or other communications options. \$2355; boards will be available in the third quarter. PEP Modular Computers, Scottsdale, AZ. (602) 483-7100. **Circle No. 447**

# PICO

*Free 136 pg. catalog*

**SURFACE MOUNT  
& PLUG-IN  
TRANSFORMERS  
& INDUCTORS**

**DC-DC  
CONVERTERS**

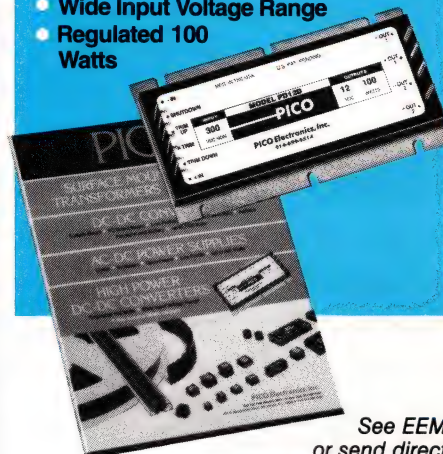
- Surface Mount • PC Board Mount
- Low Profile • Single and Dual Output
- Isolated • Industrial to Military
- up to 1000 Volts

**AC-DC  
POWER SUPPLIES**

- Linear • Switchers • Open Frame
- Low Profile • Up to 200 Watts

*New* **HIGH POWER  
DC-DC  
CONVERTERS**

- New Isolated **DUAL** Outputs
- Wide Input Voltage Range
- Regulated 100 Watts



See EEM  
or send direct  
for **Free PICO Catalog.**  
Call toll free **800-431-1064**  
in NY call **914-699-5514**  
FAX **914-699-5565**

**PICO Electronics, Inc.**

453 N. MacQuesten Pkwy., Mt. Vernon, N.Y. 10552  
**CIRCLE NO. 138**



# PICO POWER

## Unity Power Factor Front End

for AC to DC  
applications

### HARMONIC ATTENUATOR

- Universal Input
- Power Factor .99
- Efficiency greater than 90%
- Up to 400 Watts



## Single and Dual 100-200 Watt Power Modules



## Military Modules



## Single and Dual 75 Watt Mini Modules

- Miniature Size
- Dual Isolated Outputs (standard)
- Up to 100 VDC Output (standard)
- Fixed Frequency/Parallel Operation
- Wide Input Ranges 18-380 VDC
- Continuous Short Circuit Protection
- Regulated Outputs • Low Cost

- Dual Isolated Outputs (standard)
- Up to 100 VDC Output (standard)
- Fixed Frequency • Parallel Operation
- Wide Input Ranges 18-380 VDC
- Regulated Outputs
- Continuous Short Circuit Protection
- Low Cost

- Meets 704D Input Specifications
- Environmental Testing Available
- MIL STD 883 • MIL STD 810 Selected Screening
- Operating Temp. -55°C to +85°C
- Dual Outputs • Up to 100 VDC Output
- Hi-Temp Full Power Burn-In Available
- Special Output Voltages Available

Send for **FREE PICO Catalog**

## PICO Electronics, Inc.

453 N. MacQuesten Pkwy., Mt. Vernon, N.Y. 10552

Call Toll Free **800-431-1064**

in New York Phone 914-699-5514

FAX 914-699-5565



# EDN PRODUCT MART

This advertising is for new and current products.

Please circle Reader Service number for additional information from manufacturers.

## ROM-IT EPROM EMULATION SYSTEM



The Most Flexible  
EPROM Emulator  
You Can Get Today

- Emulates up to eight 4-Megabit EPROMs through one standard serial port.
- Downloads 2-Megabit programs in less than 23 seconds
- Examine and modify individual bytes or blocks.
- Accepts Intel Hex, Motorola S-Record and Binary files.
- Software available for IBM PC and compatibles.
- Base 27256 EPROM System \$395.00. Other configurations available.



**Incredible Technologies, Inc.**  
Visa, Mastercard and American Express Accepted

Order Now - It's Easy  
Call (708) 870-7027 Or Fax (708) 870-0120  
For More Information

CIRCLE NO. 234

In-Circuit  
Emulators  
For

**8051  
683XX  
68HC11  
68HC16  
80C196**

See EEM  
93/94 Pgs.  
D1304-1309

- Rental and 10-day trials available.
- Full Source-level Debugger with complete C-variable support.
- Supports virtually all members of the 8051, 80C196, 68HC11, 68HC16 and 68300 families.

CALL OR WRITE FOR FREE DEMO DISK!

**NOHAU**  
CORPORATION

51 E. Campbell Ave.  
Campbell, CA 95008  
FAX (408) 378-7869  
TEL (408) 866-1820

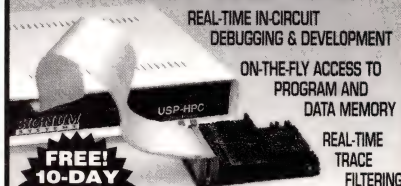
Call 408-378-2912  
Nohau's 24-hour  
information center to  
receive info via your FAX

CIRCLE NO. 254

## Real-Time Development At a Realistic Price

**SIGNUM IN-CIRCUIT EMULATORS**

**80196 • 8051 • 80186 • Z8  
DSP • HPC • 8085 • Z380**



**FREE!  
10-DAY  
TRIAL  
TRY BEFORE  
YOU BUY**

REAL-TIME IN-CIRCUIT  
DEBUGGING & DEVELOPMENT

ON-THE-FLY ACCESS TO  
PROGRAM AND  
DATA MEMORY

REAL-TIME  
TRACE  
FILTERING

WINDOWS & MOUSE USER INTERFACE

FREE USER SUPPORT

EXTERNAL UNIT WITH NO PLUG-IN CARDS

**SIGNUM**  
SYSTEMS

FOR MORE INFO OR TO ARRANGE  
YOUR 10 DAY FREE TRIAL, CALL:  
**1-800-838-8012**

CIRCLE NO. 255

## EXPRESS PROTO

Best Value in the World

for  
**POLYIMIDE & FR4  
1 to 5 DAY TURN**  
1 to 12 Layers

PRINTED CIRCUIT PROTOTYPES

2 PIECE CIRCUIT FOR FR4 .062 TH.

LAYERS	1	2	3&4	5&6	7&8
15	\$233	\$292	\$639	\$787	\$935
30	264	330	724	891	1059
60	311	389	853	1049	1137
90	358	448	980	1207	1434
120	385	486	1044	1311	1559

■ 5 PIECES x 1.34 ■ 5 DAY PRICES ABOVE  
■ 10 PIECES x 1.67 ■ UL LISTED

EXTRAS CAPABILITIES DISCOUNTS

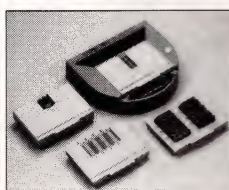
- Photo Plotting
- Testing
- Gold Contacts - \$50
- 25% - Below 8 Mil Hole
- - Below 15 Mil Hole
- SMOBC & LPI - \$50
- Buried & Blind Vias
- Polyimide Multilayer
- Full Body Gold
- Carbon Paste
- Tin nickel burn-in boards
- SMT-SMOBC
- Up to 22 layers
- Impedance control boards
- **5%**
- **10%**
- COD

FOR MORE INFORMATION CALL OR FAX

Ken Bahl ■ 1108 W. Evelyn Ave., Sunnyvale, CA 94086  
Phone (408) 735-7137 FAX (408) 735-1408 Modem (408) 735-9842

CIRCLE NO. 240

## UNIVERSAL/GANG PROGRAMMERS



**FLEX-700**

48 pin from \$945  
40 pin from \$845  
8 gang from \$845  
TUP-400 \$645  
TUP-300 \$495

Appreciated by over 70,000 users worldwide

- Supports Altera 7xxx, MACH 435, Xilinx, Intel FX7xxx, nearly all FPGA/CPLD/PLD...
- Support EPROM, 28/29F flash, serial PROM, PSD4XX/5XX, Intel/Motorola/NEC/Hitachi MPU devices. Over 3,000 devices supported.
- Test TTL 74/40/45 series, DRAM(SIP/SIMM), and SRAM. EPROM EMULATION option.
- Gang programming & stand alone option.
- Universal 44,68 pin PLCC modules.



Tribal Microsystems Inc.  
44388 S. GRIMMER BLVD., FREMONT, CA 94538  
Tel: (510) 623-8859  
Fax: (510) 623-9925

CIRCLE NO. 244

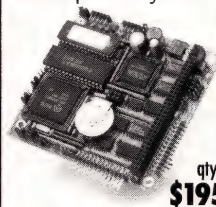


**PC/104 Bus  
Power Supply  
Real-Time Clock  
RS485/RS232  
Parallel I/O  
Printer Port**

Call for details!  
916-757-3737 or  
FAX 916-753-5141.  
24-Hour AutoFAX:  
Call 916-753-0618  
from your FAX. Ask  
for catalog 18.

Our new **Z104™**,  
a low-cost, general-  
purpose controller,  
can be the heart of  
your next project.

Quickly develop  
C-language programs  
using our integrated  
development system.



qty 1  
**\$195**



CIRCLE NO. 248



## ANALYZER-EMULATOR



### UniLab 8620

- ☐ PC Based, Zero-Wait-State Operation
- ☐ Non-Stop Analysis: Define & Refine Triggers & View Multiple Traces On-The-Fly
- ☐ Source Level & Symbolic Debug
- ☐ Built-In EPROM Programmer
- ☐ Same Base Unit Supports Most 8-bit  $\mu$ Cs &  $\mu$ Ps, including 8051, 68HC05, 68HC11, Z80, 80C196, 6502, 8085, etc.

**1-800-729-7700**

Tel: 415-327-8800

Fax: 415-327-9881

**ORION**  
INSTRUMENTS

180 Independence Dr., Menlo Park, CA 94025 U.S.A.

CIRCLE NO. 238

## MOTOROLA HC11/HC05 FAMILY DUPLICATOR

1) Programs up to 6 parts at one time from a master device.

2) Programs the OTP EPROM, EEPROM, configuration register and protection bit.

3) All operations complete in 60 sec.

4) Devices supported are: HC711E9, HC11E1, HC11E0, HC811E2, HC711D3, HC705C8, HC705D9, and others.

5) Totally self-contained.

6) Units come with a 1 year warranty and are priced at \$1295.00. Ideal for design, production, and QC.

**Circuit Equipment Corp.**

216-951-8840 FAX: 216-951-3216



CIRCLE NO. 232

## RELIABILITY PREDICTION SOFTWARE

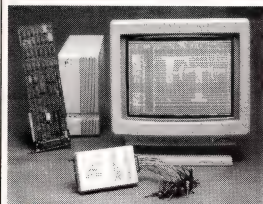
### ARE YOUR PRODUCTS RELIABLE?

The RelCalc 2 Software Package automates the reliability prediction procedure of MIL-HDBK-217, or Bellcore, allowing quick and easy reliability analysis of electronic products on your PC. Say goodbye to tedious, time consuming, and error prone manual methods!

- NEW UPDATE! VERSION 3.1 now available.
- User friendly: pop-up menus, hypertext help.
- Very easy to learn and use; quick data entry.
- Part library for rapid recall of part data.
- Global editing functions for what-if? trials.
- Reports which clearly organize results.
- Save time & money as you design for quality.
- Try our Demo Package today for \$25.

**T-Cubed Systems**, 31220 La Baya Drive, Suite 110, Westlake Village, CA 91362  
CALL: (818) 991-0057 FAX: (818) 991-1281

CIRCLE NO. 241



*Rated #1  
for  
Ease-of-use  
by OEMs  
& end users*

### Expandable Logic Analyzer plus

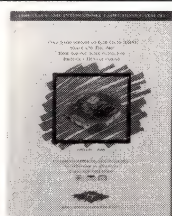
- ✓ 50 MHz and 25 MHz state and timing
- ✓ 32K sample depth, up to 192 channels
- ✓ Professional features in PC-based product
- ✓ Easy-to-use, windows-like interface
- ✓ PC-based desktop and ISA bus versions
- ✓ Digital/analog pattern generator option



EMULATION TECHNOLOGY, INC.

**800.995.4381**

CIRCLE NO. 251



*#1 in  
Adapter  
Solutions  
for over  
10 years*

### FREE 1994 Interconnect Solutions Catalog

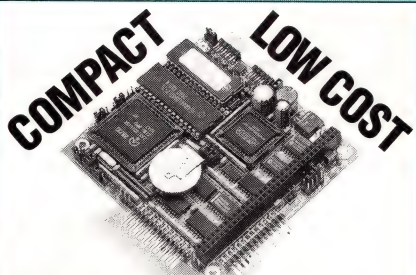
- ✓ Over 3,500 devices for one-stop-shopping
- ✓ 120 "Off-the-shelf" items available for overnight delivery
- ✓ Unlimited application consulting
- ✓ Time saving solutions for product development
- ✓ Ask about our custom designs
- ✓ Leading edge technology -- over 500 PQFP solutions



EMULATION TECHNOLOGY, INC.

**800.995.4381**

CIRCLE NO. 252



### C-Programmable Controllers

Use our controller as the brains of your next control, test or data acquisition project. From \$149 qty one. Features I/O to 400 lines, ADC, DAC, RS232/RS485, printer port, battery-backed clock and RAM, keypads, LCDs, enclosures and more! Our simple, yet powerful, Dynamic C™ makes programming a snap!

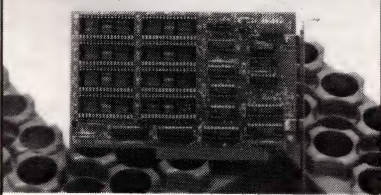
24-Hr AutoFax: 1724 Picasso  
916.753.0618. Davis, CA 95616  
Call from your FAX. 916.757.3737  
Request catalog 18. 916.753.5141 FAX



CIRCLE NO. 256

### SOLID STATE DISK

- Put DOS and Application in EPROM
- Allows Diskless Operation
- Up to 1&3 MBYTE ROM-DRIVE with 16K Footprint
- Promkit Software by Annabooks Available
- Flash EPROM Supported
- Battery RAM Modules Supported
- Made in USA



**Sealevel Systems Inc.**  
PO Box 830  
Liberty, SC 29657  
803-843-4343

CIRCLE NO. 257

## 486 Single Board Computers & Rack Mounts

3 YEAR  
WARRANTY



8 Slot 486SX-25 4MB 170MB HDD . . . \$1,495.00  
14 Slot 486DX-33 4MB 250MB HDD . . . \$1,995.00  
20 Slot 486DX-66 4MB 540MB HDD . . . \$2,495.00  
PLEASE CALL FOR CUSTOM CONFIGURATIONS.

**ORDER DESK 1-800-777-4875**



**US LOGIC**

Made In U.S.A.

5055 Viewridge Ave., San Diego, CA 92123

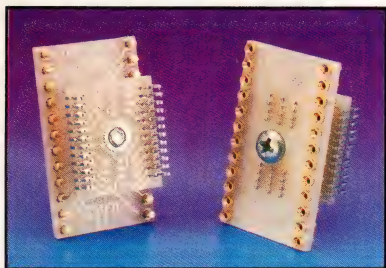
(619) 467-1100 • FAX (619) 467-1011

The Intel Inside Logo is a registered trademark of Intel Corporation.  
3 year warranty applies to Falcon-II Single Board Computer.

CIRCLE NO. 245



## SOIC TO DIP



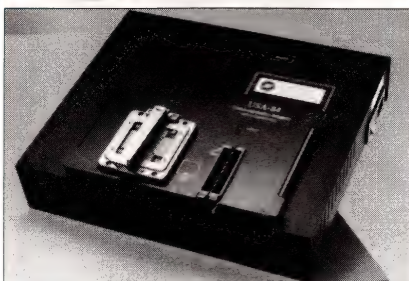
### WITH DIP/SOIC PACKAGE CONVERTER

- Convert surface mounted SOIC pattern to DIP.
- Solder to SOIC Land Pattern.
- Then plug DIP IC into DIP socket.
- DIP pins are gold plated machined pins.
- Multiple sizes available

**IRONWOOD ELECTRONICS**  
P.O. BOX 21151, ST. PAUL, MN 55121  
(612) 431-7025; FAX (612) 432-8616

CIRCLE NO. 236

# Advin



**PILOT-U84 Universal Programmer**  
**#1 in New Device Support & Expandability**  
Altera 7064, 7128, 7160, 7192 in 84-, 100- and 160-pin packages  
Xilinx 1765D, 17128 etc Intel FLEX, 87C196 K.C.KDJR, MC etc.  
Moto 68HC711, 68HC705, WSI PSD-3XX, 4XX, 5XX, PAC, SAM  
Atmel 29C040, ATF22V10 etc. AMD MACH435, 29F040, etc.  
Lattice pLSI-1000, 2000, 3000. Microchip PIC micros  
All packages to 256-pin: PLCC, PGA, QFP, TQFP, TSOP, SOIC  
800-627-2456 FAX: (408) 736-2503, Sunnyvale, CA.

CIRCLE NO. 230



## Choose the GFS POWER PAC

The new  
GFS POWER-  
PAC can be  
configured as a wide-  
range flyback transformer, a 1:1 pulse  
transformer or a high energy inductor.

- High energy storage
- Customized values
- Low DC resistance
- OCTA-PAC™ equivalent
- Inspectable solder joints

Make the right choice - choose GFS

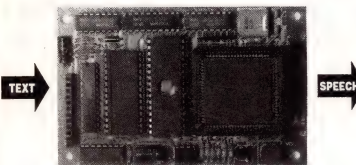
Call: 603-742-4375  
Fax: 603-742-9165

140 Crosby Road  
Dover, NH 03820-4371

**GFS  
MAGNETICS**

Octa-Pac is a registered trademark of Colltronic

## IMAGINE IF YOUR PRODUCT COULD TALK!



V8600 text-to-speech synthesizer

- Converts plain ASCII text into speech ("talking printer")
- Requires only a single 5V supply and speaker
- Unlimited vocabulary—no custom recording necessary
- Programmable pitch, rate, tone, volume, etc.
- Text, character, phonetic, tone and PCM modes
- Microprocessor, serial and printer interfaces
- Use in telecom, robotics, monitoring systems, etc.
- Less than \$100 in OEM quantities
- ISA, PC/104 and stand-alone versions available

**FREE V8600 DATA BOOK**  
USA Ph: 206 355-3800 Fax: 355-1098  
UK/Europe Ph: 4481 539 0285

**RC SYSTEMS**  
INCORPORATED

RC Systems, Inc. • 1609 England Avenue • Everett, WA 98203 USA

CIRCLE NO. 239

## You Don't Have To Burn Your Devices Like This!



## LOGICAL



Has a Full  
Range of  
High Quality  
Universal & Gang  
(EEPROMs, FLASH, PLD,  
& MICRO CONTROLLER)  
Programmers

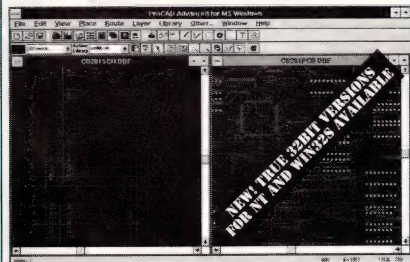
**LOGICAL  
DEVICES, INC.**  
TEL: (305) 428-6668  
FAX: (305) 428-1811

**digelec**

1 800 331-7766 Ext: 103

CIRCLE NO. 237

## Windows Schematic Capture to PCB Layout Single System Dynamic Integration \$995



Before Spending a lot of money on 80's tech. PADS, Protel, P-CAD etc, You should take a look at our 90's Dynamic "One CAD Solution"-Schematic capture, PCB, two sided SMT, Autorouter, Mechanical drafting ...  
☒ Integrated Schematic, PCB, & Mech. drafting  
☒ Real time Pin/Gate swap & Cross Probe, 1u Res.  
☒ Real time Fwd & Bkwd Annotation, Network, etc  
☒ OrCAD, PADS, PCAD, AutoCAD, Protel, etc Complt.  
☒ True 32bits, No Limits!! Call for tradeup discount  
 Full function eval. kit with complete manuals (4Bks) \$100.00 (Creditable towards purchase).  
**Interactive CAD Systems, P.O. Box 4182**  
 Santa Clara, CA 95056. (408) 970-0852, FAX: (408) 986-0524

CIRCLE NO. 235

## NOT JUST A CHIP OFF THE OLD BLOCK

LOW POWER, 16 MHz, STATIC, 16-BIT  
**MICROPROCESSORS**  
From the Original Owners  
of 65C02 and 65C816  
Technologies

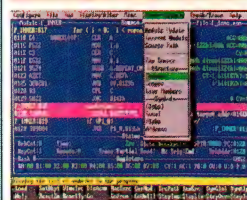
The Western Design Center, Inc.  
2166 East Brown Road  
Mesa, Arizona 85213  
602-962-4545  
602-835-6442 (FAX)

Core licenses available



CIRCLE NO. 259

## 8051 68HC11 COP8 68HC05



**iceMASTER™  
In-Circuit  
Emulators  
From \$851**

- Easy to learn & use
- Windowed interface—user configurable
- Real-time and non-intrusive
- Source level debug

- Support for structures, arrays, unions and pointers
- Trace buffer with advanced searching capabilities.
- Fast serial (RS-232) link to any PC, even laptops.
- Broad support of derivative devices/interchangeable probe cards
- Rental and 10-day trials available.
- Call today for free demo disk

(800) 638-2423

**MetaLink™**  
Corporation

Phone: (602) 926-0797  
Fax (602) 926-1198

**Now  
DS80C320  
8xLSI  
8xCS75**

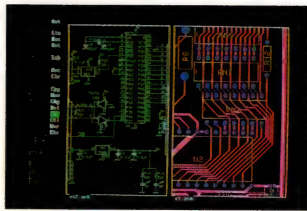
MetaLink Europe GmbH  
Telefon: (08091) 2046  
TeleFax (08091) 2386

CIRCLE NO. 253



# HiWIRE II

Schematic and PCB Software



With support for expanded and extended memory, HiWIRE II can handle your most demanding schematic and PCB designs. The unique HiWIRE II editor allows you to display and edit schematics and PCBs simultaneously, using the same commands for each. HiWIRE II is \$995 and is guaranteed.



Wintek Corporation  
1801 South Street  
Lafayette, IN 47904  
Phone: (317) 448-1903

1 - 800 - 742 - 6809

CIRCLE NO. 246

## Fast & Friendly

The handheld programmer/emulator for demanding engineers.



S4 programs EPROMs, EEPROMs, FLASH, PICs, 8751 micros. It emulates RAM and ROM too!  
To get S4 on your desk tomorrow, or to simply request literature, call:  
**800-328-2336 or 407-649-3335**  
Fax: 407-649-3310 BBS: 407-649-3159



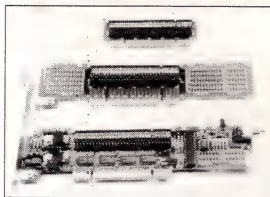
Dataman Programmers Inc.  
22 Lake Beauty Drive,  
Suite 101, Orlando,  
FL 32806, USA.

15 years of innovative solutions in the palm of your hand.

Dataman Programmers Inc.,  
22 Lake Beauty Drive,  
Suite 101, Orlando,  
FL 32806, USA.

CIRCLE NO. 250

## PCI BUS EXTENDER and BUS ISOLATION EXTENDER



5.0 VIO  
3.3 VIO  
Four  
Models  
Hundreds  
Sold

Speed up your PCI product development and testing time using the best featured and best valued PCI Bus Extenders and Bus Isolation Extender.

Call now for more information.

**Adex Electronics**

22994 El Toro Road

Tel: 714-768-3211

Lake Forest, CA 92630

Fax: 714-472-9654

CIRCLE NO. 249

## Analyze

T.30, T.4 & T.6 performance up to 14.4 Kb. Commented analyzes with corrections suggested. Simulate calls with included test libraries, write your own, or capture real-world calls for playback.

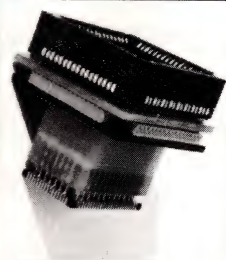
Used in Design, Q.C., Mfg., & Service.

Call today for product information or application assistance.

**GRAY ASSOCIATES**  
(408) 251-0263

## Simulate

CIRCLE NO. 233



**QFP and SOIC SMT Adaptors for Emulators and Logic Analyzers**

- Two part modular construction
  - 62 mil high generic base replaces the chip variety of tops can be purchased separately, e.g. emulator, logic analyzer, ZIF socket, cable, etc. tops
- Easy to solder
  - 160 leads under 1 minute
  - no special equipment or experience required
- Rugged construction, minimum size, short traces
- Vertical extensions available
- Deliveries from stock to 3 days on most products

EDI Corp., PO Box 366, Patterson, CA 95363,  
Tel.: 209/892-3270, Fax: 209/892-3610

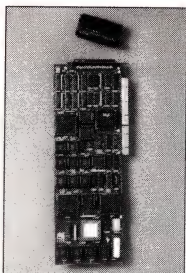
CIRCLE NO. 258

# Consistency is key



## to the power of EDN Product Mart

CIRCLE NO. 260



### PC-EISA TO ENCORE HSD DATA LINK/EMULATION

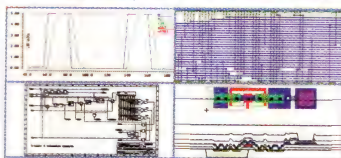
Using our PCEHSD® card and file transfer software, files can be moved between a PC EISA bus computer and an Encore computer HSDII board. The PCEHSD also emulates the HSDII; therefore, the PCEHSD can drive a HSDII compatible peripheral device. Transfer rates in excess of 10Mbytes/second. DOS I/O routines and interactive test program, and UNIX driver available. This product is an excellent tool for hi-speed data acquisition, monitoring or product test fixture.

**APPLIED DATA SCIENCES, INC.**  
P.O. Box 814209, Dallas TX 75381-4209  
(214) 243-0113 • FAX (214) 243-0217

CIRCLE NO. 231

## ASIC SOFTWARE

for PC, Sun, HP and Macintosh



### Tanner Tools Pro™

A Complete VLSI Design System

- Schematic entry **S-Edit™**
- Circuit simulation **T-Spice™**
- Gate-level timing simulation **GateSim™**
- Full-custom layout editor **L-Edit™**
- Design rule checker **L-Edit/DRC™**
- Automatic place-&-route **L-Edit/SPR™**
- General device extractor **L-Edit/Extract™**
- Layout vs. Schematic comparison **LVS**
- CMOS layout libraries for MOSIS & Orbit

Free L-Edit demo disk - Call (818) 792-3000 or Fax (818) 792-0300

The Leader in Affordable ASIC Design Tools

**TANNER RESEARCH**

180 N. Vinedo Avenue  
Pasadena, CA 91107

CIRCLE NO. 242

## FLEXIBLE Memory EMULATORS

Now with  
**Flash**  
memory

EE08+



- 90 day WARRANTY.
- 10 day MONEY-BACK GUARANTEE.
- Supports Read and WRITE access by TARGET.
- Download and VERIFY from HOST.
- View/Edit SRAM contents while target is running.
- Full screen ASCII/HEX editor included.
- Libraries provide high level access to emulator.
- Daisy-chain up to 4 units for multi-EPROM targets.
- Field upgradable to 4Mbit (27040) emulation.
- Battery back-up, PLCC and 16bit adapters available.

**TechTools**  
(214) 272-9392  
FAX: 494-5814

Models start at  
**\$129**

CIRCLE NO. 243



## ELECTRONICS ENGINEERS

Experienced Senior level Electronics Engineers to manage a small R&D facility are being sought. The engineer should have a broad background in diverse areas of electronics. The expertise should include analog, RF, microwave, digital and PC based systems design. The engineer should be motivated and interested in new ideas and concepts in electronics R&D laboratory or facility. We provide excellent salary and benefits. Please write to:

**CRS Employment**  
P.O. Box 9244  
McLean, VA 22102

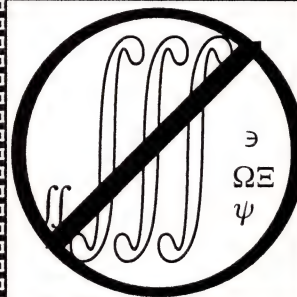
If you want to reach over 163,000 engineering professionals, in over 52,000 locations, EDN Career Opportunities is the best place to advertise your positions.

Get the attention of 100% qualified engineers and managers involved in designing or developing electronic products, who look to EDN Magazine's Classified section for career opportunities.

**JACKIE DANIELS**  
**Tel:**  
**1-800-603-4859**  
**Fax:**  
**1-617-630-3925**

# Without Tears™

Learn DSP and  
put your  
knowledge to  
work  
**IMMEDIATELY!**



**COMING TO A  
CITY NEAR YOU**

Washington, DC  
Austin, TX San Jose  
Scottsdale, AZ  
Atlanta Denver  
Long Beach, CA

Call 7 Domain Technologies, Inc.

**800-967-5034**

**404-587-4812**

Hours 9-5 EST.  
Ask for a brochure.  
Our 2-Day Advanced  
Course is ready. Call for  
more info.

By taking this  
3-Day Course  
you will really  
learn DSP.  
**Guaranteed!**

**EUROPEAN SALES  
REPRESENTATIVES WANTED**  
MIC/SMD Chip capacitor, U.S. manufacturer, is seeking professional Rep. firms for European markets. Interviews during Electronics/Munich Nov. 8-11, 1994. Send profiles to:

**Jackie Daniels**  
c/o EDN P.O. Box 0994-01  
275 Washington St.  
Newton, MA 02158

**IOWA MIDWEST**  
RF/TELECOM WIRELESS  
**NEBRASKA-MINNESOTA-ILLINOIS**  
I have immediate openings for Design Engineers and Technical Project Managers with BS/MS plus 3 to 10 years RF/Radio design experience in any of the following areas: RF circuit design (100 MHz to 3.0 GHz), Receivers, Transmitter Exciters, Low-noise Frequency Synthesizers, Power Amplifiers, Spread Spectrum Modulation, Digital Radio DSP. These positions are all with top non-defense companies in good Upper-Midwest locations

**DON GALLAGHER, MSEE**  
Gallagher & Brei Associates  
1145 Linn Ridge Rd., Mount Vernon, IA 52314  
(319) 895-8042 • Fax (319) 895-6455

EDN

PROFESSIONAL SERVICES



**PRODUCT ENGINEERING  
& MFG., INC.**

Over 25 Years Experience in  
Complete Mechanical Services  
• **Industrial Design & Rendering**  
• **Enclosure Design**  
• **Mechanism Design**  
• **Reverse Engineering**  
• **Product Evaluation**  
• **Prototyping**

From hand held Plastic Products...  
.....Too Complete Machines

**CALL FOR BROCHURE**  
Virginia 1-800-848-2553

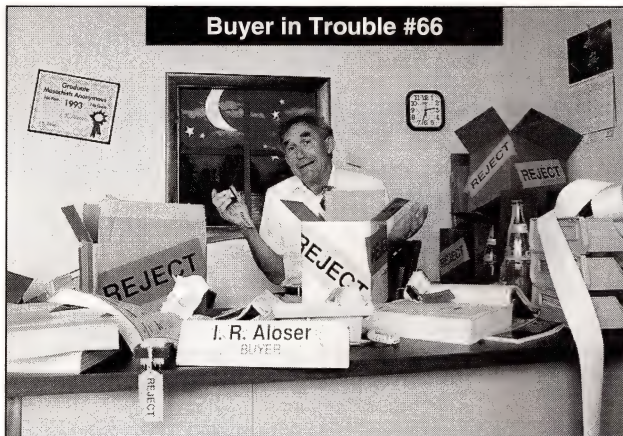
**USE YOUR FAX TO  
FIND COMPETITIVE  
COMPONENTS & PRODUCTS  
PRICES IN JUST ONE  
BUSINESS DAY**  
PHONE# 610-667-9170 • FAX# 9165



Company	Page	Circle	Company	Page	Circle	Company	Page	Circle
3M Components	96	46	LeCroy Corp	14	82	Sharp Electronics	11*	34
AMP Inc	93	47	Linear Technology	76	146		50F*	36
Abbott Electronics Inc	50A*	48		85-86			79*	37
Advanced Micro Devices Inc	30-31		Loughborough Sound Images Ltd	50G*	84	Siemens AG	8-9*	149
Apex Microtechnology Corp	64	65	Maxim Integrated Products	105	159	Siemens Components	11	153-156
Atmel Corp	45	66		107	160	Siliconix	12-13	
Audio Precision	87	69	Melcher AG	50H*	136	Sony Semiconductor	53	103
Burr-Brown Corp	83	137	MemTech	111	85	Sony Semiconductor Europe	50D*	185
CEIBO	133	145	Mentor Graphics	88	86		99*	189
Compass Design Automation	113	70	Mesago Messe & Kongress GmbH	101*	87	Spectrum Software	129	104
Compunetics Inc	111	71	Messe Munchen GmbH	111*	31	Stag Programmers	128	105
Concurrent Computer Corp	63	123	MicroSim Corp	17	150-152	Stanford Research Systems Inc	100	186
Condor D.C. Power Supplies	57	72	Mini-Circuits	3	161	Startech Semiconductor	103	111
Crystal Semiconductor	84	74		81	162	Tektronix Inc	47	106
Cypress Semiconductor	C4		Mitsubishi Electronics America Inc	36-37	38	Teledyne Electronic Technologies	94	117
Datel Inc	79	75	Motorola Computer Systems	45*	88	Teledyne Relays	134	118
Digi-Key Corp	1	1		53*	89	Texas Instruments	6-7	108
Digital Equipment Corp	48-49		Murata Electronics	64	73		19-20	
Diversified Technology	70-71	9	NCR Corp	28	91		21	107
	73	19	NEC Corp	32-35*	121		32-35	
EM Microelectronics Marin SA	118	139		36-37*	122	Tokin Corp	69	109
ESL Inc	95	76		74-75	147	Toshiba America Electronic Components	22-23	98-99
EUROM Flash Ware Solutions Ltd	24	144	National Instruments	C2	32	Toshiba America Information Systems	130	188
Ecliptek Corp	106	77	Oyster Terminals	94	92	Toshiba Electronics	94*	110
Elantec	116	124	P-CAD	59-61	93		95*	110
Ericsson Components	114	78	Pico Electronics	122	163	TransEra Corp	104	112
Frequency Devices Inc	25	4		98	138	Underwriter's Laboratories	119	187
Fujitsu	110	157		121	138	United Parcel Service	99	113
Hansen Corp	108	49	Philips Semiconductors	26-27	40-44	Vishay Resistive Systems	102A-B	
Harris Semiconductor	2	39	Power Trends Inc	50	94	W R Grace	112	114
Hewlett-Packard	115*		Power-One Inc	55	95	Wavetek	97	115
	117*	158	Prem Magnetics	101	96	Wyle Laboratories	8-9	116
Hewlett-Packard Europe	50B,C*			118*	96			
	50E*	79		128	17			
Hirose Electric USA	120	26-30	Quality Semiconductor Inc	115	148			
Illinois Capacitor	102	80	Quicklogic	67	97			
Integrated Device Technology Inc	109		Raltron Electronics	62	33			
International Rectifier	C3	125	Reliability Inc	101	102			
J.S.T. Ltd	14*	81	Samsung Semiconductor	22-23*	164			

\*Advertiser in European edition

## Buyer in Trouble #66



## Feeling Rejected

"3913... 3914... 3915... 3916... 3917... 3918...  
I shoulda called Prem. Their pc power transformers are 100%  
tested... 3919... 3920...."

I really shoulda called Prem.

You oughta call Prem!"



Where Quality Really Counts!

For Prem's new catalog or additional product information, call or write  
Prem Magnetics, Inc.  
3521 North Chapel Hill Road, McHenry, IL 60050.  
Phone: 815-385-2700. FAX: 815-385-8578.

CIRCLE NO. 17

## Eclipse - The Ultimate Universal Programmer

... for WINDOWS™



Programming Into The Next Millennium

- Eclipse - Unchallenged in Speed & Sophistication
- Stand-alone or Remote operation with Windows\* or DOS\*
- From 96 to 256 pin drivers as standard, Stag's Scalable Architecture permits expansion beyond 500 pins
- Universal DIP & PLCC modules - do away with stacks of fragile pin adaptors
- High performance pin drivers - test even the fastest PLDs
- High speed serial (115K baud) and parallel interfaces

USA &amp; Canada:

Tel: (408) 988-1118 Fax: (408) 988-1232

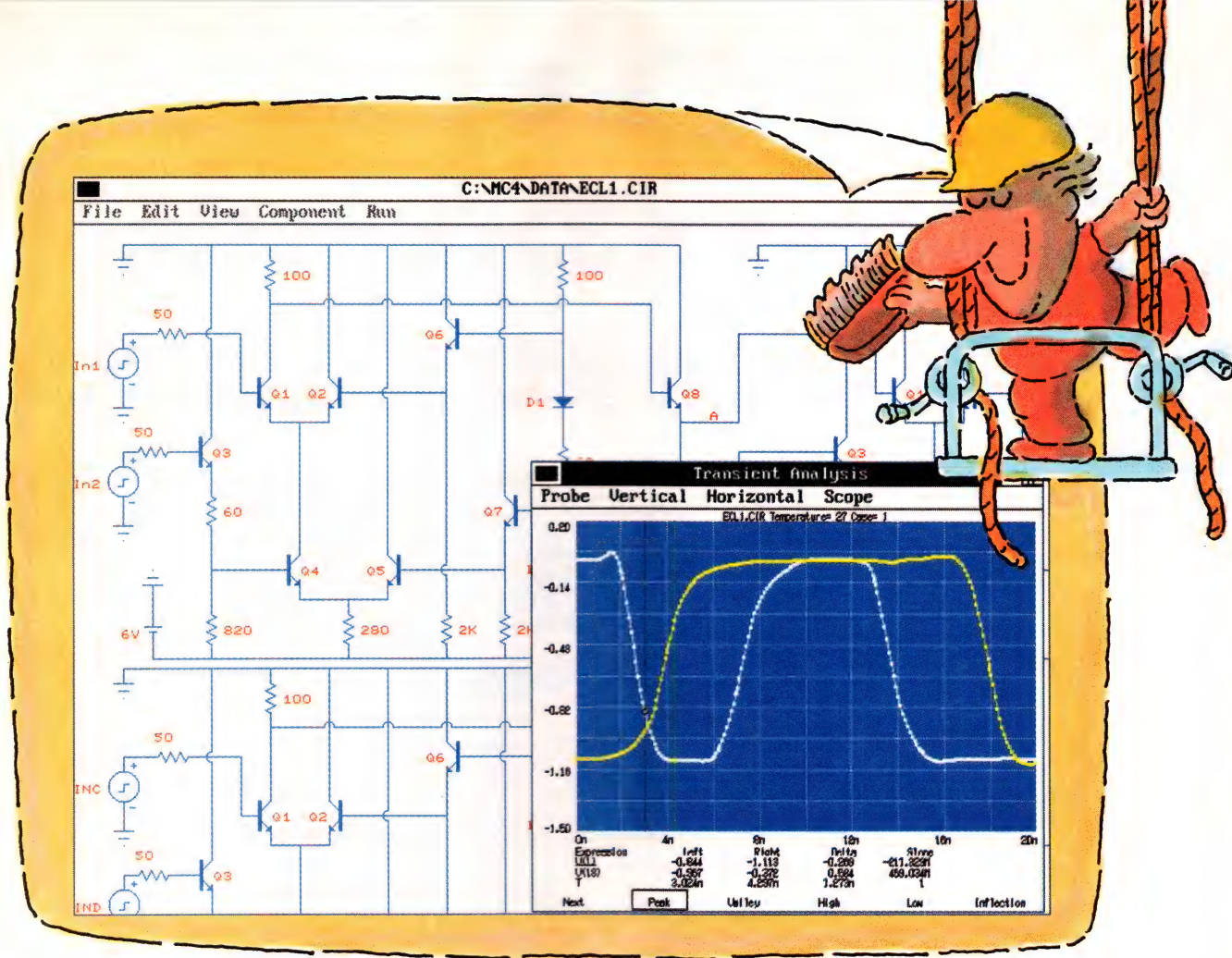
U.K. Europe &amp; R.O.W.:

Tel: 44 (707) 332148 Fax: 44 (707) 371503

stag PROGRAMMERS

CIRCLE NO. 105



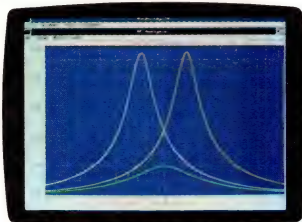


# INTRODUCING MICRO-CAP IV.™ MORE SPICE. MORE SPEED. MORE CIRCUIT.

PC-based circuit analysis just became faster. More powerful. And a lot easier. Because MICRO-CAP IV is here. And it continues a 12-year tradition of setting CAE price/performance standards.

Put our 386/486 MICRO-CAP IV to work, and you'll quickly streamline circuit creation, simulation and edit-simulate cycles — on circuits as large as 10,000 nodes. In fact, even our 286 version delivers a quantum leap upward in speed. Because, for one thing, MICRO-CAP IV ends SPICE-file-related slowdowns; it reads, writes and analyzes SPICE text files and MC4 schematic files. It also features fully integrated schematic and text editors. Plus an interactive graphical interface — windows, pull-down menus, mouse support, on-line HELP and documentation — that boosts speed even higher.

Now sample MICRO-CAP IV power. It comes, for example,



AC Analysis

from SPICE 2G.6 models plus extensions. Comprehensive analog behavioral modeling capabilities. A massive model library. Instant feedback plotting from real-time waveform displays. Direct schematic waveform probing. Support for both Super and Extended VGA.

And the best is still less. At \$2495, MICRO-CAP outperforms comparable PC-based analog simulators — even those \$5000+ packages — with power to spare. Further, it's available for Macintosh as well as for IBM PCs. Write or call for a brochure and demo disk. And experience firsthand added SPICE and higher speed — on larger circuits.

**Spectrum**

1021 S. Wolfe Road  
Sunnyvale, CA 94086  
(408) 738-4387 FAX (408) 738-4702



# The Toshiba T4700C Series

## A notebook so powerful, it breaks the sound barrier.



The Toshiba T4700C Series can run your most intense applications or even help you run a presentation. With its SL Enhanced i486™DX2 50MHz processor, it easily handles graphics-rich programs. The built-in multimedia capabilities let you create and give breakthrough presentations anywhere. And Toshiba's advanced color gives you a choice of either stunning TFT or eye-popping Dynamic-STN dual-scan displays. With so much going for it, buying a T4700C Series notebook is a very sound decision. **For a Toshiba dealer near you, call 1-800-457-7777.**

**Incredible Sound:**  
An integrated sound system and built-in speaker let you enjoy fantastic sound whenever you want.



**The only computer you'll ever need:** The optional Desk Station IV, lets you instantly connect to your network, printer, VGA monitor, mouse, and full-size keyboard.



**Two separate PCMCIA slots:** A 16mm and a 5mm slot are your keys to expansion, —for modems, storage and more.



**A multimedia roadshow:** Headphone or external speaker port and microphone jacks make the T4700C Series perfect for presentations.



#### T4700CT

- 9.5" dia. color TFT-LCD active matrix display
- 256 simultaneous SVGA colors at 640x480 resolution

#### T4700CS

- 9.5" dia. color Dynamic-STN dual-scan display
- 256 simultaneous SVGA colors at 640x480 resolution

#### BOTH MODELS

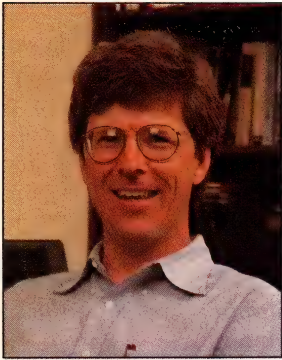
- 50MHz SL Enhanced i486™DX2
- 8MB RAM expandable to 24MB
- 200/320MB HDD
- Two PCMCIA slots (16mm and 5mm)
- Integrated graphics accelerator
- VL local-bus video
- Built-in microphone
- WAV audio capabilities

- Audio jacks: headphone/speaker, microphone
- NiMH battery for extended life
- QuickCharge battery recharge system
- 3.5" 1.44MB floppy disk drive
- BallPoint™ 2.0 mouse with QuickPort™
- MaxTime™ Power Management system
- LCD status icon bar
- DOS™, Windows™, and Windows Sound System™ software pre-installed



In Touch with Tomorrow  
**TOSHIBA**





**JACK GANSSE,**  
EMBEDDED-SYSTEMS  
CONTRIBUTING EDITOR

# The paperless office: must or myth?



Experienced engineers know that a new college graduate is really nothing more than a blank slate with no experience and little practical knowledge. The four years of cramming Maxwell's equations and cranking triple integrals give a nice theoretical grounding in the basis of our profession but leaves much lacking that only on-the-job training can fulfill. I remember that our instructor did not allow us to solder in our lab courses because he feared we might burn ourselves. Appalling, but true.

Your white-collar self-esteem may bristle at these words, but engineering is very much like the trades people practiced hundreds of years ago. We've substituted "junior engineer" for the word "apprentice" and "senior engineer" for "journeyman," but master craftsmen hand down most of the practical aspects of our profession to newcomers.

This isn't bad; because technology has a half-life of, perhaps, three to five

years, no college could ever adequately prepare engineers for the work place. An engineer not constantly involved in self-education becomes obsolete in short order.

One thing we never discussed in college was drawings—amazing, since most engineering output is nothing but drawings. Sure, we sketched a few simple schematics and analyzed circuits on the blackboard, but, somehow, we never addressed the creation, maintenance, and updating of the drawings that are the product of our work.

Every small company goes through a phase of creative chaos. Crank out a few sheets of OrCAD schematics and hand-annotated assembly drawings, and *ship the product*. In time, the product line broadens, necessitating more drawings (all stored in a drawer somewhere). Management expects new hires to build and maintain the products, often working from memory. They'll often hear comments like "Oh yeah, we always put a 10k resistor in that spot," or "Jeez, you forgot the mod we do to that version of the product."

This is a classic case of the company's systems breaking down. Management texts talk

about planning and inventory-control systems but ignore the most important system for manufacturing and engineering: the drawing-control system.

My company went through this evolutionary phase, during which it accumulated hundreds of drawings. Sure, we had bills of materials and assembly drawings, but they were impossible to track. Which was the current version? What changes were implemented between versions?

In desperation, I tasked a young engineer with developing a formal drawing system, not realizing that, having had no experience with functioning systems, he had no idea where to start. The result was, well, primitive.

On a memorable cross-country flight shortly thereafter, I pounded in a specification for a document-control system, drawing on the experience I had obtained as a junior engineer years before. Frankly, I pirated the concepts from a former employer. That system, in turn, is derived from one used by the airplane industry. Though our system has refinements for handling embedded designs (PAL and ROM files, for example), it looks much like any system dating from the '50s or even '40s.

Now, I secretly smile, realizing that my company's crop of engineers will probably take this third-generation system along to other employers in the future, keeping many of the core concepts for two simple reasons: It works, and it has become another comfortable tool in their skills bag in their journey toward master craftsmanship. There is nothing new under the sun!

Teaching apprentices is very much like having children. Your own kid is a source of genetic immortality; the protégé you mentor likewise perpetuates a piece of you.

## The paperless office

Although journalists have written plenty about the evolution to the paperless office, few technology companies have made this transition, even in the highest of the high-tech environments—engineering. Sure, we now use schematic capture instead of a pencil and vellum, and word processors rather than scrawled notes. But almost all electronic documents get reincarnated in paper form.

**"The most important system for manufacturing and engineering is the drawing-control system."**

The paperless drawing system described in this article is available on the EDN Readers' BBS (computer bulletin-board system). Phone (617) 558-4241 with modem settings 1200/2400 8,N,1. From the Main System Menu enter SS/freeware and then from the /freeware SIG menu enter rkGAN1894.



Production wants paper drawings for the assemblers. Test needs test procedures and schematics on paper. Let's face it: Even engineering wants the schematics on paper. You can scribble and make notes on a paper schematic. You can't do that on screen.

Electronic documents suffer from another flaw: Every drawing runs under a different application! Schematics use one of dozens of capture packages; assembly drawings may be in AutoCAD or another format; even text documents can be in Word, Lotus, or any of a hundred other formats. You cannot display and manipulate all of the system's documents unless you own all of the applications on your workstation.

Does this suggest that an organization should standardize on a single word processor, single database, and the like? That's the tack we've taken.

The new reality of a drawing-control system must recognize that, although masters are inevitably in some computer format, working copies are almost always on paper. Paper is *not* bad per se; it is yet another component of a modern information-management system.

To handle the realities of standard office equipment, all schematics and other documents should, if possible, be formatted for 8.5×11-in. paper. The days of D-sized schematics are long gone. You can't copy them without a monstrous blueprint machine, you can't fax them, and you can't store them without special cabinets. My company's entire drawing system fits in one drawer of a standard file cabinet—a space-conserving, easy-access format that greatly simplifies life.

"But," you sputter, "we've always used huge drawings!" Times and technology change. Embrace change. My dad says that in the pre-Mylar days they did drawings on starched linen in ink. One bead of sweat in those pre-air-conditioned '50s could ruin a week's work.

When I first entered this field, all we managed were drawings and bills of materials. The digital age has only increased the kinds of "documents" any reasonable drawing system must manage.

Perhaps, though, it makes sense to outline the goals of a document-control system:

1. Guarantee that all departments are using accurate, up-to-date, drawings.
2. Control product versions, so produc-

tion knows how to make each kind of product.

3. Provide a historical record of changes, so the service group can bring older products up to current revisions without heroics.

4. Ensure that adequate backups exist so that the knowledge in the system can survive a fire or malicious intent.

Goals 1 to 3 have been around since the dawn of engineering. I suppose John and Washington Roebling them-

**Almost all electronic documents get reincarnated in paper form.**

selves built the Brooklyn Bridge with a primitive drawing system that obviously functioned well. The fourth goal is a result of challenges from the computer age and the realization that a company must survive despite any disaster.

How do you manage a document that lives in some purely electronic form? Schematics and artwork should have paper (or film) copies filed in the drawing drawer, but what about the original files?

One solution is to define an electronic repository. At my company, one computer has a master directory, available to everyone over the network, where a copy of every critical file is stored. Modern networks are great because even a simple one lets you define read/write access rules and passwords. There's little problem leaving these files available to everyone, but a paranoid outfit could easily restrict write-access to those folks with a "need to write."

Every project has its own subdirectory, with further subdirectories containing ROM, PAL, CAD, and word-processing files. Draconian rules and an assigned "enforcer" ensure that changes to the files get copied back to the master computer.

With all of the files on one machine, it's easy to run weekly backups to tape. In effect, we can back up everything critical to the business in 30 minutes from a single machine and need not rely on forgetful and busy employees to run regular backups of their own systems. In a break-in a year ago, a burglar destroyed or stole almost every decent computer. Yet we lost virtually no data.

PALs and ROMs pose special documentation challenges, because they are physical devices that you must purchase. As a result, they require call-out on a bill of materials. Yet, the device itself is incomplete until it is burned with the proper equations or program. Our solution is to call out the chip on the bill of materials, with an associated drawing number that describes the part's programming.

The ROM/PAL drawing includes the file names of all source-code modules used to build the equations or program. PALs are always a single .PDS file compiled via PALASM. ROMs invariably are composed of dozens of source-code modules. By listing every file used, its full file name on the master computer, and the required make files, it's possible to re-create the program from the backup files, even if a software engineer's computer dies (or is stolen).

No system can work unless it's clearly understood who is in charge of keeping it up to date. Tasking an individual with the responsibility of managing the drawing system means everyone knows whom to turn to for help and advice. The responsible individual knows what is expected, and management can crack the whip. The drawing system is too important to leave to chance. Its management should be part of the responsible person's annual review.

*The E Myth* by Michael E Gerber (1986, Harper Business, New York) examines how businesses start, grow, and sometimes choke on their own success. The book's most important point is that the entrepreneur should work *on*, not *in* the business. That is, spend time designing systems and procedures that make it possible for the business to thrive, despite its success.

Though Gerber never mentions drawing systems, document management is surely as important as any other system. EDN

*Jack Ganssle is the president of Softaid, a vendor of emulators and other embedded-systems tools. His idea of heaven is sailing across oceans, although the ugly face of common sense precludes these dreams too often. Contact him via CompuServe at "76366.3333," or via Internet at "76366.3333@compuserve.com." Send mail c/o Softaid, 8310 Guilford Rd, Columbia, MD 21046.*



# CEIBO

## Development Tools of Choice

DS-186 real-time emulator supports microprocessors of the 80C186 family. The emulated devices are 80C186/8/XL/EA/EB/EC, V40/50, 8086/8 and more. The selection of a different microprocessor is made by replacing the microprocessor in the adapter or changing the adapter. The system features Full Speed Emulation up to 30MHz, 1 Mbytes of Zero Wait-State Mapped Memory, 8K Frames Dynamic Trace Buffer, 1M Hardware Breakpoints and 115KBaud RS-232C Communication Link. Breakpoints are qualified by instruction fetch, instruction execution, data contents, read/write from/to memory and I/O. The Trace display shows source, assembler and bus cycles. The system runs at the frequency of the crystal on the adapter or from the clock source supplied by the user hardware. The software supplied as standard is Paradigm Debug and Locate.

### Ceibo DS-186 In-Circuit Emulator

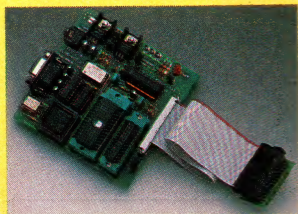


### Ceibo DS-51 - Microprocessor Development System

Ceibo DS-51 is a real-time in-circuit emulator dedicated to the 8051 family of microcontrollers. It is serially linked to an IBM PC or compatible host and carries out a transparent emulation on the target microcontroller. DS-51 supports the new low-power and low-voltage 8051 microcontrollers and derivatives. The system can emulate the microcontrollers using either the built-in 5V power supply or any voltage applied to the target circuitry. This selection is done by means of software control. The permitted voltage range is from 1.5V to 6V or higher. DS-51 emulates almost every 8051 derivative in the complete voltage and frequency range specified by the microcontroller manufacturer. The minimum frequency is determined by the emulated chip characteristics, while maximum frequency is up to 40MHz. The software includes Source Level Debugger for PLM and C, Assembler Debugger, Performance Analyzer, On-line Assembler and Disassembler, Conditional Breakpoints and many other features. Standard systems are supplied with 128KBytes of Internal Memory, 64K Hardware Breakpoints, 32K Real-Time Trace Memory and personality probe supporting most of the 80C51 microcontrollers.

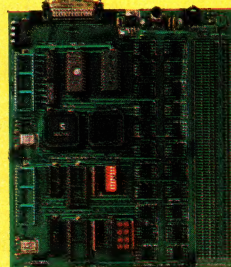
### Development Tools

Ceibo offers a broad line of dedicated Development Tools for emulating different Microcontrollers and including all the necessary elements to design and debug your embedded system. Among these tools are DB-501, DS-750 and DS-752.



### DB-51 Development Board

Ceibo/Philips DB-51 is a system design board dedicated to the 80C51 microcontrollers and derivatives. The software supplied with DB-51 includes Source Level Debugger for Assembler, PLM and C, Performance Analyzer, On-line Assembler and Disassembler, Software Trace, Conditional Breakpoints and many other features. DB-51 provides 32K of user code memory and has a special wire-wrap area for prototyping.



### MP-51 - Programmer

Ceibo MP-51 is a high-quality Microcontroller, Flash Memory, EPROM and PLD Programmer dedicated to all the microcontrollers belonging to the 8051 family, 24 to 32-pin EPROMs, high-density PLDs and PSD devices. MP-51 allows to enable or disable the PLD or Microcontroller security capabilities and handles Lock Bits and Encryption Table available in several Microcontrollers. MP-51 loads different file formats: Intel Hex, Intel OMF, Binary, Motorola S-records, etc. Adapters are available for all the possible packages, such as DIP, LCC, PLCC, SO, and QFP.



## A Complete Line of Development Boards, Programmers and In-Circuit Emulators

# CEIBO

For more information,  
contact us today:  
TEL: 1-800-833 4084

CEIBO USA  
7 EDGESTONE COURT,  
FLORISSANT, MO 63033  
TEL: 314-830 4084  
FAX: 314-830 4083

CEIBO DEUTSCHLAND  
RHEINSTRASSE 32  
D-64283 DARMSTADT  
TEL: 06151-27505  
FAX: 06151-28540

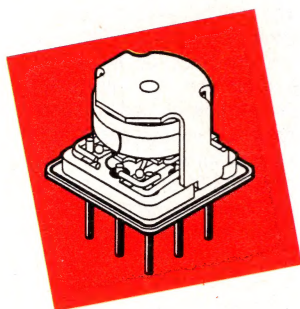
CEIBO ISRAEL  
MERKAZIM BLDG., 5 MASKIT ST.  
P.O.BOX 2106, HERZELIA 46120  
TEL: 972-9-555 387  
FAX: 972-9-553 297

CEIBO SPAIN  
JOSUÉ LILLO 41  
MADRID 28018  
TEL: 91-477 8995  
FAX: 91-477 9075

SWEDEN - TEL: 0589-19250, FAX: 0589-16153 • ITALY - TEL: 051-727252, FAX: 051-727515 • FRANCE - TEL: 061-855767, FAX: 061-851914 • OTHER COUNTRIES - FAX: 972-9-553 297



# THE TELEDYNE COMMERCIAL CENTIGRID® RELAY



Cost Effective Performance  
with  
Proven Reliability

**T**he commercial 172 Centigrd® relay has become a standard where price/performance ratios are the critical design criteria.

This hermetically sealed relay locks out harsh environment, features a low profile and tiny footprint for direct PC board plug in. Low intercontact capacitance and low contact circuit losses provide excellent RF characteristics up through UHF. All this in a low power, DPDT

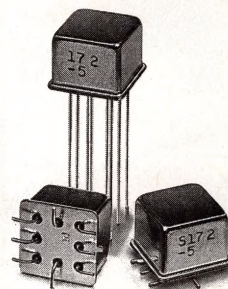
relay, with proven reliability.

The S172 surface mount version brings many of the commercial Centigrd® relays features to SMT applications and they are especially user friendly. These relays can be provided in tape and reel or IC tube carriers for automated production.

Applications include automatic test equipment, medical electronics, test instruments, telecommunications and automotive circuitry.

The commercial Centigrd®.

It gives you the benefit of a relay with an extraordinary price/performance ratio. For price, delivery, and more technical information, call **1-800-284-7007** or Fax us at 1-213-779-9161.



**TELEDYNE RELAYS**  
Innovations In Switching Technology

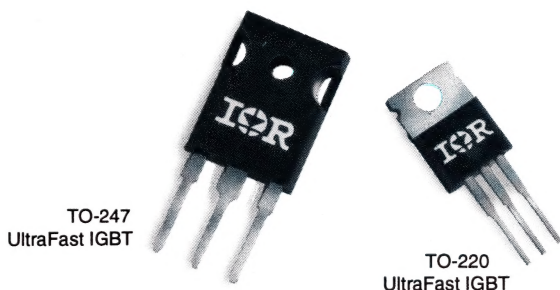
**Home Office:** 12525 Daphne Avenue, Hawthorne, CA 90250 • Telephone: 213-777-0077 • Fax: 213-779-9161

**Overseas:** GERMANY, (0611) 7636-143; ENGLAND, (081) 571-9596; BELGIUM, (02) 717-52-52; JAPAN, (03) 3797-6956



# Motor control savings.

Or how to design noise-free inverters  
that switch faster for less money.  
The 1200V IGBT *CoPack*.



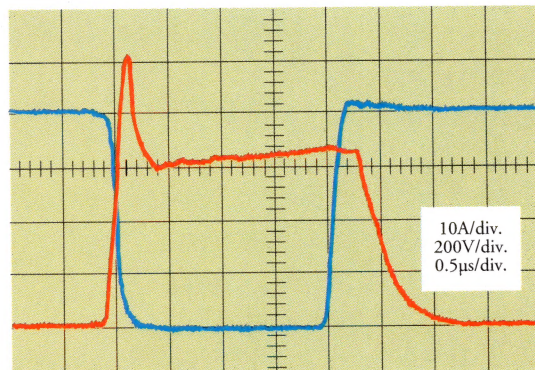
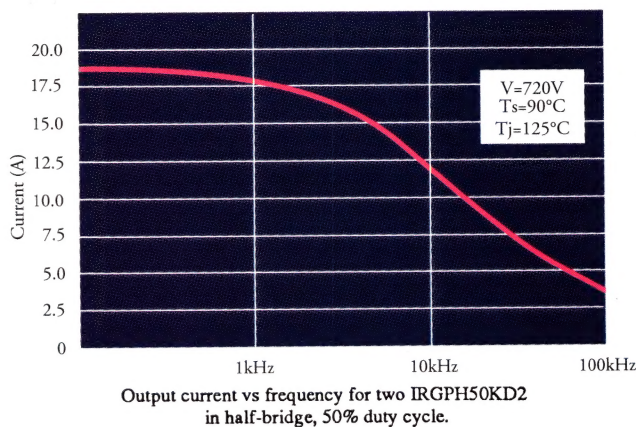
Now you can design simpler, more efficient motor control inverters. That switch at 20kHz. Quietly. Without snubbers. All it takes is our UltraFast 1200V *CoPack* with built-in diode.

You cut system costs with less parts. Get the lowest conduction loss. Fastest switching speed. Short circuit withstand. And super-soft recovery. All from more than 200 IGBT part numbers.

Rated from a few amps up to 50 amps. And value-priced to save you money. Delivery? Right from stock. Call for data on today's most cost effective IGBT line. 310-322-3331, ext. 2529.

You'll save more than you think.

*Available now at key IR distributors.*



Switching waveforms of the IRGPH50KD2 in a clamped inductive load at  $T_j = 90^\circ\text{C}$ .

## **IR** International Rectifier

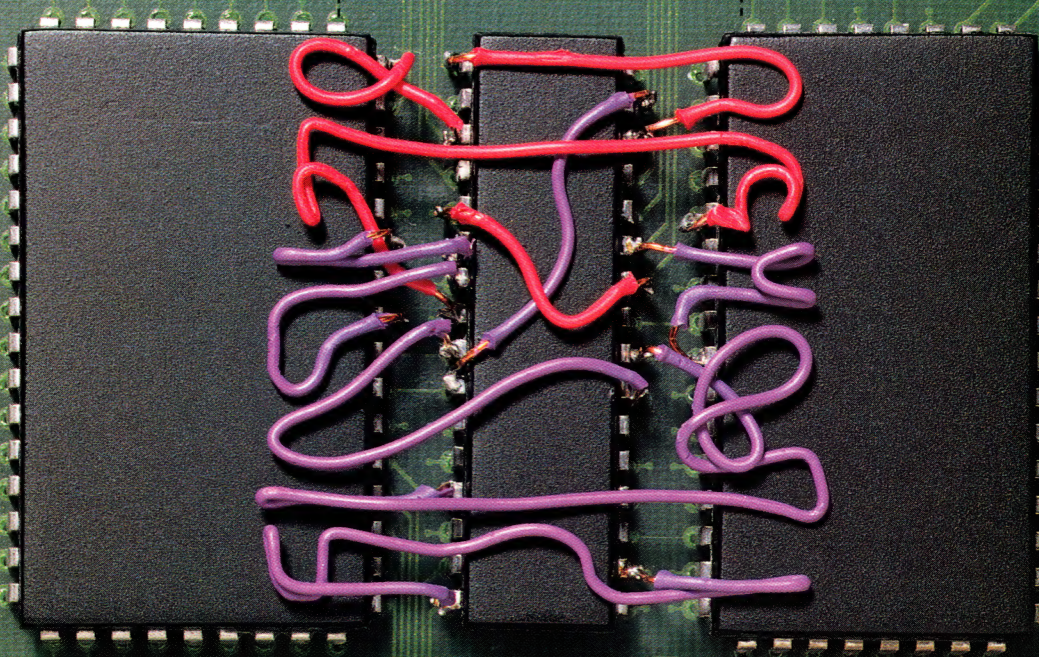
WORLD HEADQUARTERS: 233 KANSAS ST., EL SEGUNDO, CA 90245, USA 310-322-3331, FAX 310-322-3332, TELEX 66-4464. EUROPEAN HEADQUARTERS: HURST GREEN, OXTEY, SURREY RH8 9BB, ENGLAND (0883) 713215, FAX (0883) 714234

HEXFET Power MOSFETs • IGBTs • Schottkys • Power ICs • SMDs • Modules • Rectifiers • SCRs • Bridges



FOLD PAGE  
HERE

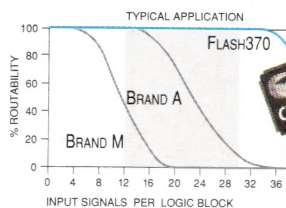
TO  
HERE



You found it! FLASH370 is a family of seven erasable complex PLDs—with up to a whopping 256 macrocells and 256 I/O pins. Even more remarkable is their 100% routability. This combines with the shortest pin-to-pin delays of any architecture through all speed paths—a blazing 8.5 ns for the 32-macrocell, 44-pin CY7C371. What's more, you get this high speed with 100% timing predictability. So you never have to struggle with variable timing again.

**SURE, RECORD-BREAKING  
SPEED IN A COMPLEX PLD IS A BIG PLUS  
BUT IT SHOULDN'T  
ROUTINELY BE A TEST OF YOUR ABILITY  
TO HANDLE PLIERS.**

(FOLD AS SHOWN FOR THE ALTERNATIVE.)



The FLASH370 family's exceptionally clean and simple architecture helps get your products to market faster. And as part of Cypress's comprehensive UltraLogic™ family, the FLASH370 is supported by Warp™ VHDL open design tools. So start designing with a data sheet instead of a soldering iron. And watch the competition fold.

**Call for your free FLASH370 design kit: Warp2™ design tool for the CY7C371, sample certificate and product data. 1-800-858-1810\*, Dept. C4H.**

\*In Europe, fax requests to the above Dept. at (32) 2-652-1504 or call (32) 2-652-0270. In Asia, fax requests to the above Dept. at 1 (415) 940-4337. Warp and UltraLogic are trademarks of Cypress Semiconductor © 1994 Cypress Semiconductor, 3901 North First Street, San Jose, CA 95134 Phone 1-408-943-2600.

**ULTRA**  
L O G I C

 **CYPRESS**